Stress Health and Fitness in Operational Aircrew

by

Walter M. Williamson

A Thesis submitted in fulfilment of the requirements

for the award of

MASTER OF PHILOSOPHY

(Human Biology)

of Loughborough University of Technology

OCTOBER 1983

Supervisor: Dr. E.J. Hamley

Department of Human Sciences

A B S T R A C T

STRESS HEALTH AND FITNESS IN OPERATIONAL AIRCREW

WALTER M. WILLIAMSON

To fulfil the various tasks and roles in the Royal Air Force efficiently, good 'health' is implicit but 'fitness' is not so specifically defined and specifically relates to task. Stress elicits various responses which might sometimes improve performance and frequently impairing it. This study seeks to identify within a military aircrew group the possible relationships between stress, health and fitness.

A physical profile was developed to evaluate the groups health and fitness. The physical profile involved a system of sub-maximal measurement of oxygen uptake ($\dot{V}O_2$), weight, skinfold thickness, blood pressure and an actuarially scaled health questionnaire. The physiologic characteristics of 82 aircrew; 74 fast jet, fixed wing and 8 rotary wing employed in search and rescue duties were investigated. Thirty eight of this group volunteered for further investigations, physiological and psychological, to evaluate individual influences on work performance. Physiological measurements comprised ambulatory heart recorders, both in training flight simulators and while flying aircraft. Psychological factors influenced by personality traits were identified by using the Clinical Analysis Questionnaire (CAQ). With reference to well established theories on Stress, a series of individual factors of health and fitness were seen to influence performance in the special tasks of operational aircrew.

CONTENTS

KEY TO FIGURES, TABLES AND PHOTOGRAPHS

FIGURES

TABLES

PHOTOGRAPHS

ACKNOWLEDGEMENTS

Initially I would like to thank wholeheartedly the members of both 43 Sqn (F) and 111 Sqn RAF Leuchars during the period October 1980 - July 1982 for their selfless support and participation in this study. Secondly I am most indebted to my supervisor and director of research, Dr E.J. Hamley for his continued encouragement and valuable advice throughout the study, in particular his early guidance and support in formulating the research which maintained my resolve to overcome some early obstacles. Thirdly I would like to thank Dr J. Thompson, Department of Physiology, University of Dundee for his advice on health and fitness evaluation upon which much of that aspect of the study was based. Fourthly I am indebted to Dr W.J. Guild, Department of Physiology, University of Edinburgh for use of his ambulatory monitoring equipment and in conjunction with Mrs Pat Gordon, cardiology technichian, Edinburgh Royal Infirmary analysed the recordings, providing a depth of experience and knowledge for which I will be eternally grateful. Finally I must thank the many personnel of Royal Air Force Leuchars, Scotland where this study was done in particular the staff of the simulator whose interest and forebearance provided the necessary experimental basis on which much of the data was collected.

Forty – Three Squadron – 43 Sqn(F)

'QRA' Scramble

I. "THE FIGHTING COCKS"

We are under-exercised as a nation. We look instead of play. We ride instead of walk. Our existence deprives us of the minimum of physical activity essential for healthy living.

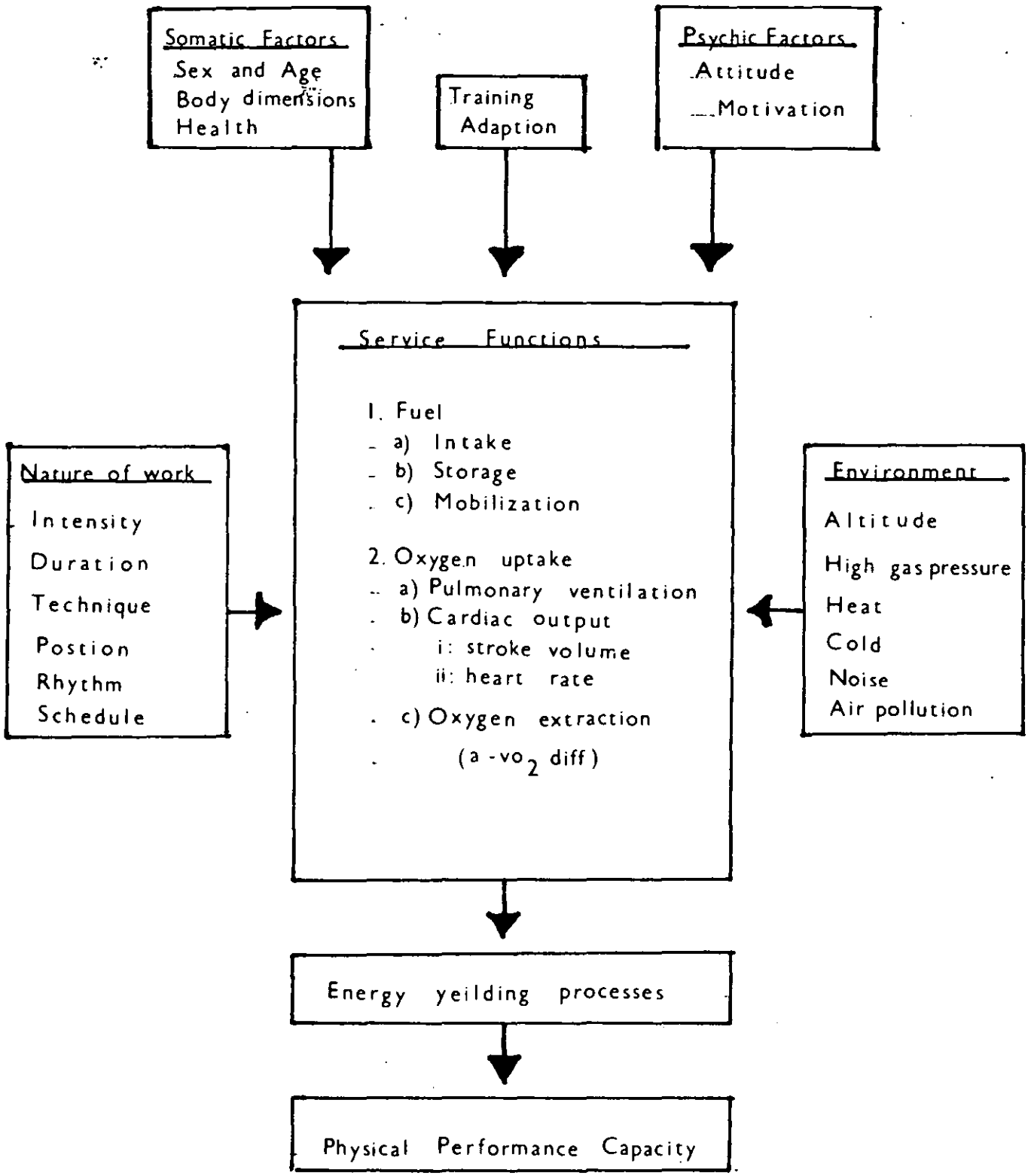
John F. Kennedy (1961)

1. INTRODUCTION

As a Physical Education Officer (PEdO) in the Royal Air Force for the last 12 years I have been involved with my contemporaries in the frustrating, and on going search and debate on scientifically defining 'fitness' with particular relevance to Air Force Personnel. Working concepts of 'fitness' have for many years been short-lived, further complicating the question of the relationships of fitness to stress and health in the individual and resultant effect on work performance. Our base discipline has perhaps understandably always tended to orientate our answers towards the physical. Achievement of desirable and recognizable physical standards, of the moment, would immediately identify the individual as 'fit'. Such labelling implied a bottomless resource to succeed at any task; failure to achieve such standards would raise doubt on an individuals efficiency regardless of his specific task.

My study in the following chapters will define the factors of stress, fitness and health as I recognise them and relate them to a military task. However I consider implicit in any results, discussions or recommendations similar if not comparable effects in other areas of society. In particular my study is centred on aircrew, chosen not only for homogeneity of task but also the readily appreciated involvement of stress, fitness and health in that task. The model proposed by Åstrand and Rodahl (Fig 1) will be used as a framework throughout the study to define and discuss

FACTORS AFFECTING PHYSICAL PERFORMANCE CAPACITY.



(After Astrand and Rodahl, 1977)

FIG 1.

the three factors and their relationships in respect to aircrew physical performance capacity. This framework provides an excellent overview of the interplay of many factors, internal and external which must be taken into consideration in such evaluation. In addition the Transactional Model of Stress propounded by Cox and Mackey Fig 2 (see 2) further defines and identifies these internal and external factors complementing ideally the overall framework.

These internal and external factors are what Lager (1974) in his thesis Pilot Reliability calls most suitably 'provocations'. Possibly the past and some of the present approaches to improve fitness, health and stress levels may be heightening these provocations.

One factor commonly confused with stress is that of fatigue. This factor once defined and stated as "Fatigue is what fatigue complaints are about". But other than being mentioned briefly here in the introduction it will be outside the scope of this study and therefore when mentioned it will be in general terms and accepted as a 'provocation'. A past study by the Ministry of Aviation (AGARD 1969) on measurement of fatigue in relation to attention level suggested three levels, 'immediate', "duty-day" and 'long-term' workload - fatigue. Lager (1974) further defined it in behavioural terms as a breakdown of total 'Process" and a breakdown of 'Attention' only. He further extended these two aspects by relating function breakdown/exhaustion and attention breakdown/inability to stay awake. By outlining a definition of fatigue the aim is to prevent confusion of definition in the following discussion on stress (see 2) with particular reference

to the aircrew role in the multi-capability Phantom Jet Fighter. Evidence of fatigue in some situations will be cited, at times the origin of the portrayed symptom could be debated to be either stress or fatigue.

The age range studied in the group will be 21 years to 45 years. Age factor carries its own inherent problems. It is known that between 30 and 45 we have an average impairment of 5% in basal metabolic rate and nerve conduction velocity, in addition mean work tempo is slowed down 10% in the 30-45 years age range. Cardiac output is lowered by 15% in the 30-45 years range and also in this group vital capacity of lungs, and maximum breathing capactiy flow is lowered by 15% and 20% lower respectively. In addition kidney plasma flow is lowered by 15% at 45. Add to this degradation of physical factors such as sight failings, thermoregulatory problems and others requiring both monitoring and if possible enhancement. This suggests maintenance of physical function through exercise. Cognitive skills also suffer with age, 'unlearning' being more of a problem than learning. The adding of programmes to the many functional programmes already stored heighten the opportunity and risk of mixing them up in operation. Throughout the study there is evidence of a number of strategies employed to overcome any age disadvantage. These occur both in the physical and psychological aspects.

In relating health to physical fitness a number of problems are inherent. Most evidence available is both anecdotal and circumstantial. Also a problem of terminology has often resulted in the confusion of definition of what is fitness, and what is health and vice versa. This looseness of terminology permits the

use of either term dependent on the impact desired or group to impress. Much of the belief on their relationship has for many years rested on the maxim "mens sarna in corpore samo". However, more scientific studies into cardiovascular disease and obesity have suggested physical fitness and exercise to be prophylactic in those areas.

Morris, Heady and Raffle (1956) stated the hypothesis that "Men in physically active jobs have a lower incidence of coronary heart disease in middle age than men in phycially active jobs". Since then many studies have been produced which support this hypothesis Morris et al.s (1956) in particular.

Hall, Dixson, Barnard and Pritikin (1981) reported a case study on a individual who in 1976 exhibited 100% occlusion on both femoral arteries; through dietary modification and exercise training he completed the Chicago Marathon in 1978. Tests in 1981 on the same individual revealed an increase in blood flow due to enlargement or dilation of the deep femoral arteries and existing collateral vessels.

The effects of exercise and diet on Coronary Heart Disease (CHD) have been cited by Hage (1982) in an article in the Physician and Sportsmedicine as being contributory in reducing fats and cholesterol. This reduction will have a corresponding lowering of the risk of atherosclerosis. Also stated in this paper is the evidence of raised high-density lipoproteins (HDL) by aerobic exercise known to be an important factor in removing plaque deposits.

Lass (1980) suggests screening of individuals, particularly the middle-aged, prior to exercise prescription but does consider it

advantageous to health.

Studies by Montoye, Gayle and Higgins (1979) suggested a relationship of reduction of aerobic efficiency ($\dot{V}O2$ max) with bad health habits of smoking and alcohol consumption. They discounted age as a factor accounting for the reduction where the individual was a known smoker.

Contrary to these relationships suggesting health and physical fitness to be strongly correlated a study by Sedgwick, Brotherhood, Harris-Davidson, Taplin and Thomas (1980) showed that CHD risk factors did not improve with increased physical activity and fitness. However, their criteria of exercise and intensity, 2 hours/week moderate to heavy, is arguably not sufficient or standardized to be called regular.

Pollock, Foster, Sailsbury and Smith (1982) did report improvements on a group of 1362 individuals in both men and women on reduction of body weight, body fat, resting heart rate, increased $\dot{V}O2$ max, flexibility, and muscular strength and endurance. Their criteria of exercise and intensity was 3 hours/week.

Despite the possible criticisms of these studies and the many others with a similar theme of inadequate controls, confounding indepedent variables, and potentially spurious correlations including (Leon and Blackburn 1977., Melby, Forbes and Brown 1977), evidence was considered sufficiently strong by a Joint Working Party of the Royal College of Physcians of London (1976) who recommended that:

"There is sufficient evidence to justify a major concern about the sedentary life in relation to coronary heart disease and to

justify efforts to encourage the habit of physical activity at all ages in both men and women".

Clinical evidence overwhelmingly supports the contribution to ill health of obesity in association with other factors of hypertension, glucose intolerance, and raised blood cholesteral levels. Studies by Åstrand and Roldahl (1970) suggest a possible link between reduced physical activity being contributory in problems of obesity. A report by Shephard (1977) does tend to support this theory in that he stated that increased physical activity and dietary control appeared to provide the most effective means of reducing body weight"

Physical fitness provides a broader margin of safety between maximal work capacity and the work demands of everyday life (Astrand and Rodahl 1970) Hence, at the same absolute rate of work the cardiovascular strain imposed on the fit individual is considerably less than that imposed on the unfit individual Åstrand and Rodahl (1977) have identified the high correlation between maximal oxygen uptake and total work, giving increased endurance and efficiency. However aircrew are very rarely involved in arduous physical tasks, grading their work intensity (see 4) evaluates their level of work at no more than moderate, even in high active combat flying phases. This finding has been previously cited by Littell and Joy (1969) on rotary wing aircrew and by Tiller, Greidor and Graliak (1957) and Sharp, Patrick and Withey (1971) on fixed wing aircrew.

Therefore, justification of the necessity for a high level of physical fitness for aircrew does arguably appear to be a waste of time. The value of physical fitness to aircrew where their

work load was low was stated by Goldman (1971) to be of no advantage.

Much work has been produced which tends to suggest aircrew would gain little advantage from physical fitness. No increase in tolerance to acceleration stress was cited by Meeham and Jacobs (1959) Cooper and Loverett (1966) Klein et al (1969). Similarly on aspects of resistance to orthostatic hypotension, weightlessness, the G Factor and other environmental stresses it was considered their was no physiological advantage to aircrew in being physically fit.

However, Myles and Chin (1974) did report enhanced tolerance to environmental heat stress as did Pugh (1967, 1969) on increased survival potential to cold stress in individuals who were physically fit.

One weakness of approach in the studies above who report little or no advantage of physical fitness to aircrew is that their measurements are normally only of a physiological nature. Very little or no consideration is given to the mechanics and musclature of the individual.

A recent study by Epperson (1983) in the USAF identified G tolerance to be related to muscle-tone. In fact in a controlled group undergoing weight training, compared to a running group to develop aerobics, and a 'no-exercise' group the weight training programme increased tolerances by 39%.

Many claims are made for being physically fit, such as improved health, greater resistance to psychological strain and to fatigue, and enhanced self-image. Some claims are based on anecdote or circumstantial ie the study group is selective.

Aircrew may possibly be considered to fall into the latter group they are generally young, screened both psychologically and physically, and the unwanted consequences of the sedentary life are unlikely to become apparent until after their flying careers have ended. Inherent fitness will generally carry them forward into middle-age and barring accident the gradual erosion of their flying status and efficiency will go unchecked.

Lager (1974) recognizes that a change of 'behaviour' in the normal pilot is both directly and indirectly related to a high risk for a change in reliability. However, he also states that since aircrew selection procedures include behavioural (personality) aspects the main problem is the energy loss in the normal pilot. The concept of 'energy' is both a mental and physical resource which when diminished may result in a behavioural change, becoming a spiral effect if not controlled. He suggests that 'stress' may be a lesser problem than the need of 'control' and the resource with which to do it.

These 'stresses' on aircrew will be DISCUSSED in Chapter 2 with specific relevance to the many tasks and roles fulfilled by Phantom aircrew. Their personality characteristics will be identified (see 4) with the intention of discovering any possible strategies inherent in the group governed by personality or other criteria such as age/experience in compensation of Stress, Health and Fitness influences.

The breadth of the study has the main objective of identifying any possible relationships between health, fitness and stress in operational aircrew. However, secondary to this is the intention to formulate suitable methods of evaluating individual health and

fitness factors. With such information it may then be possible to prescribe personal exercise lifestyles and suggest suitable intervention strategies in nutrition, exercise, stress management and control of smoking. By employing such tactics it may be possible to increase individual resource to manage both potentially stressful situations and perceived stress while flying, enhancing his overall efficiency.

A sedentary life is the real sin against the Holy Spirit. Only those thoughts that come by walking have any value.

Nietzsche (1888)

2. STRESS

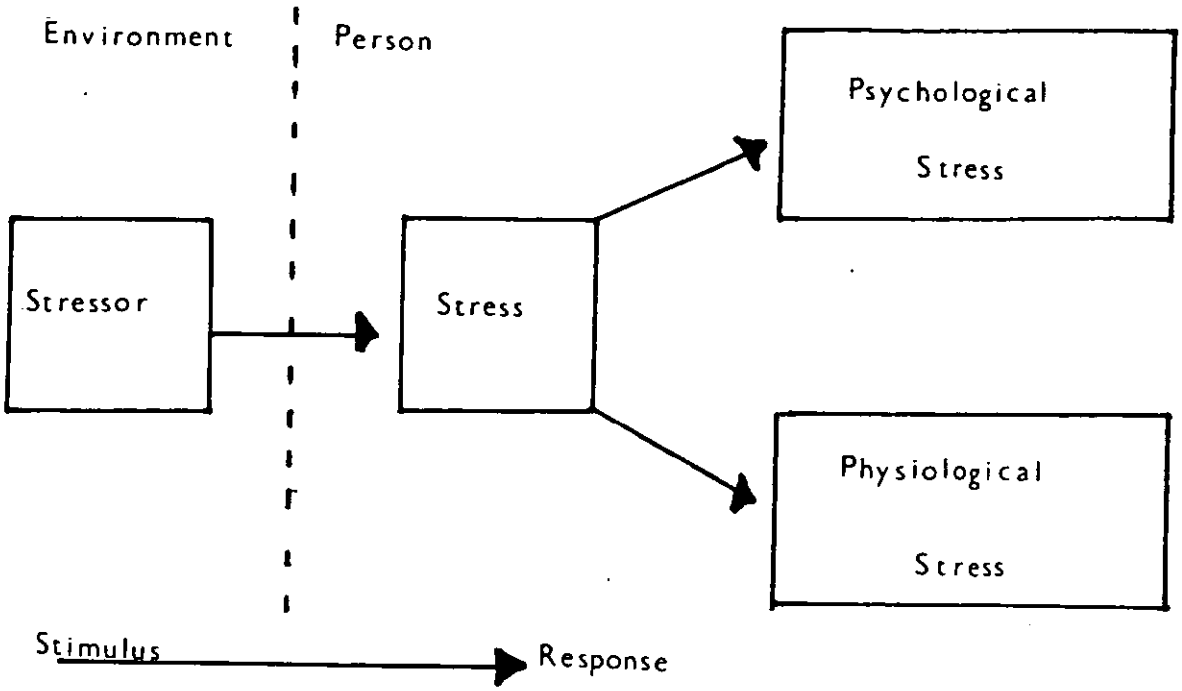
2.1 Introduction

The word stress is common to our everyday language and is often cited as the cause of many of mans present ills. Any study involving stress has the problem common to all, that of definition. As a word and definition it has a variety of meanings dependent on individual discipline. Stress to an engineer varies according to his specialism, psychologists refer to psychological stress,sociologists speak of social stress yet others refer to biologic stress, all giving signs of confusion. Yet to the layman, if questioned if he has experienced stress he will assure you he has.

Scientific approaches to the study of stress by several authors in the field. Such as Lazarus (1966), Appley and Trumbell(1967) Levine and Scotch (1970), McGarth (1970) and Cox (1975) reveal stress to be defineable in three groups. Firstly where it is treated as a dependent variable resulting in an identifiable response. Secondly where stress is described in terms of the stimulus characteristics of a disturbing or noxious environment. This approach similarly treats stress as an independant variable for study. The third approach put forward by Cox (1975) is that of lack of 'fit' between the person and his environment. This is known as the Transactional Model of stress which has common ground with both the Response and Stimulus based models. Environmental effects in all three refer to both internal and external environments involving the person and both his physical and psychological environments.

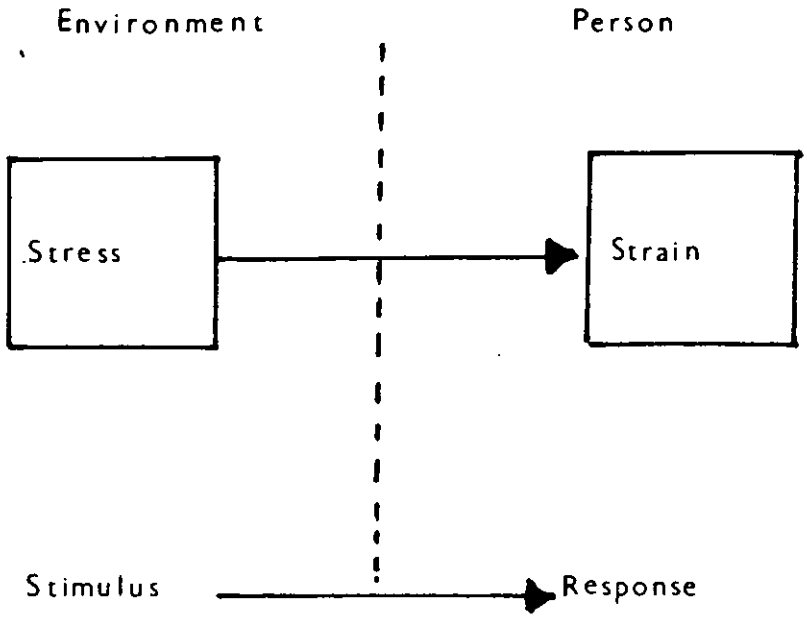
RESPONSE – BASED MODEL

FIG 2



The response-based model is simplistic and linear in approach. Selye (1957) regarded stress as the response of the bodily systems in the presence of a stressor, where the stressor is the agent, situation or condition which the individual person regards as stress inducing. It was his approach that is considered the basis and impetus which produced the response based model.

STIMULUS-BASED MODEL
FIG 3



This approach is the one more commonly used in everyday language and corresponds to the popular dictionary model of stress. When considering this approach the stress is treated as an independent variable requiring appreciation of what stimuli are diagnostic of the stress. With reference to this study Symonds (1947) in a discussion on psychological disorders in RAF aircrew stated 'it should be understood once and for all that (flying) stress is that which happens to the man, not that which happens in him; it is a set of causes, not a set of symptoms. A major weakness in this approach is making a definitive judgement on what is stressful about a particular situation. Some situations may obviously be stressful, too hot or too cold for example but the stressful aspects of a pilot or navigators cockpit may not be at all obvious.

Similarly difficulties in quantifying the latter MODELS degree of stress present arise with this approach. In addition it does not allow for the individual appreciation of what is generally regarded as stressful; being an independent variable what is stated to be stressful is based on normative data and values.

2.2 Transactional Model (Cox and Mackay)

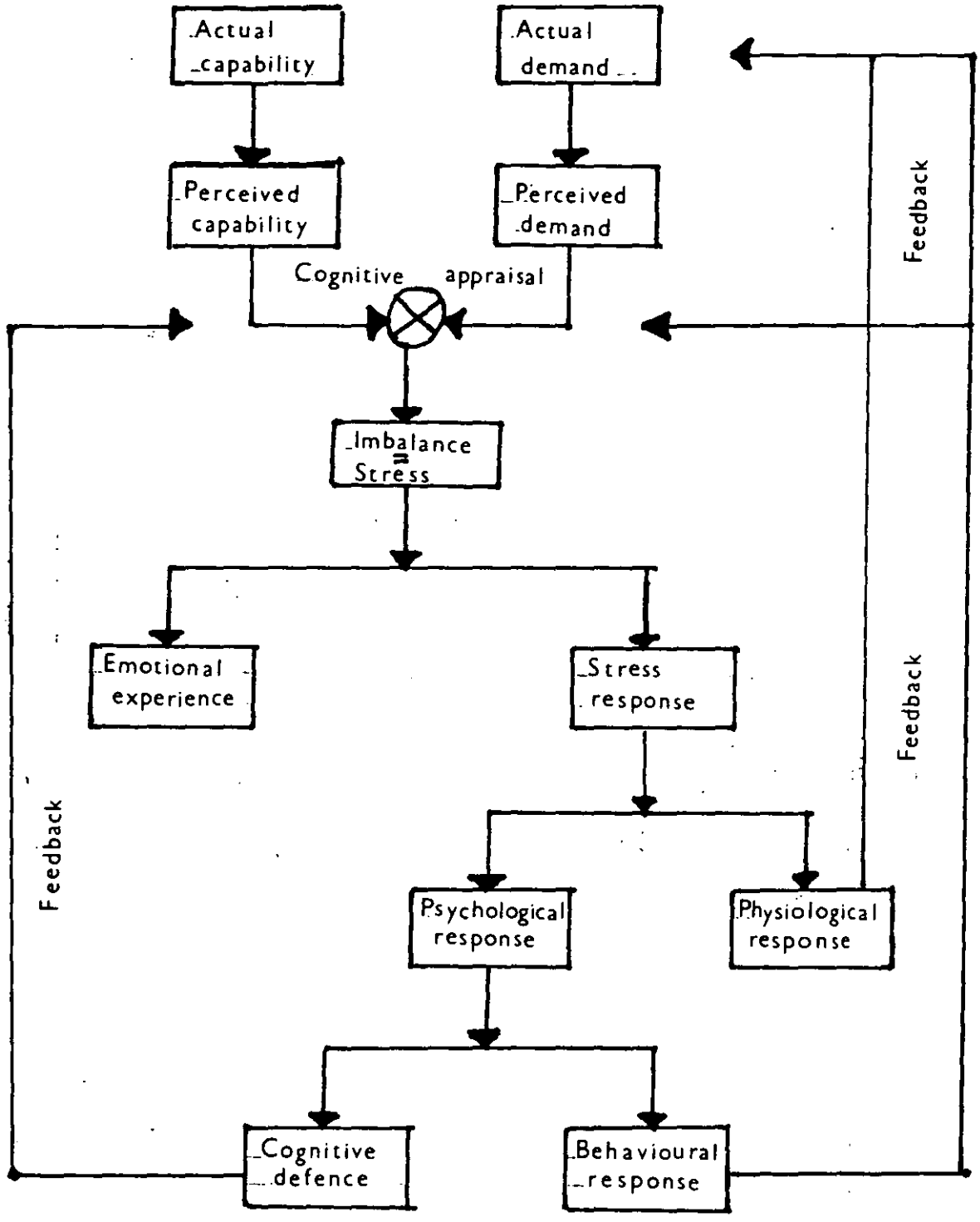
Fig 4 displays the transactional model propounded by Cox and Mackay (1976). It is a model which they state as being eclectic in that it fuses both the stimulus and response-based models but in doing so it emphasises the ecological and transactional nature of the definition. Its strength as a defining model lies in its emphasis being on the individuals perception of the stress and it is a psychological process which gives rise to any response. In addition unlike the other models which are linear in concept the feedback components of this model make it cyclical in nature.

Cox (1978) summarizes his model in the following definition of stress.

'Stress' it is argued, can only be sensibly defined as a perceptual phenomenon arising from a comparison between the demand on the person and his ability to cope. An inbalance in this mechanism, when coping is important, gives rise to the experience of stress and to stress response. The latter represent attempts at coping with the source of stress. Coping is both psychological (involving cognitive and behavioural strategies) and physiological. If normal coping is ineffective, stress is prolonged and abnormal responses may occur. The occurence of these and prolonged exposure to stress per se, may give rise to functional and structural damage. The progress of these events is subject to great individual variation.

Common to all three definitions but possibly with greater emphasis in the transactional model is that stress is a result of a particular relationship between an individual and his environment. Perception of stress is individual by nature thus

FIG 4. TRANSACTIONAL MODEL OF STRESS



(AFTER COX and MACKAY 1976)

labelling of situations as 'stressful' or 'not stressful' is not possible. A situation maybe considered to be potentially stressful or stressful to a number of individuals but generalizations are difficult and unreliable. This is further complicated by individual response to stress being variable making generalizations difficult.

Social background differences again provide difficulties in making generalizations on stress labelling from one group to another.

However, accepting that any model attempting to define stress would have inherent weakness due to the complex and variable character of the phenomenon it is considered that the final model and definition is most adequate for the purpose of this study. The transactional model will be referred to when discussing stressful or perceived stress situations involved in flying a high performance jet fighter.

The attraction of the model are as follows:

a. It is eclectic in that it draws from both response and stimulus-based definitions but being transactional it shows stress to be a complex and dynamic system.

b. It emphasises the individuality of the phenomenon, being perceptual in nature and psychologically based.

c. Unlike the response and stimulus based definitions with its feedback components it is cyclic rather than linear.

To explain the system it can be broken into five recognizable stages. Firstly demand on the individual must be stated to be an internal factor, albeit generated externally. The individuals to satisfy his psychological and physiological needs self initiates

the internal demand. His following perception of both his capability and this demand form the second stage. It is when those two components are not balanced stress occurs. It must be reiterated that it is his perceived capability and demand which if unbalanced give rise to stress because on enhanced perception of his ability or poor perception of demand will permit him to work on unaware of his limitations, thus without stress. The important area is the cognitive appraisal. With aircrew as with all occupations, training in the many stressful situations will enhance the area of cognitive appraisal and provide suitable coping responses. This area permits the influence of individual factors such as personality, giving rise to the many and varied coping responses.

In reaction to the stress the individual then suffers a subjective or emotional response. In addition this gives rise to a physiological change e.g. increased adrenalin which in conjunction with cognitive and behavioural patterns produces a possible coping response to alleviate or reduce the stressful influences. This third stage is regarded as the stress response and often considered as the end point of the process. However, as stated by Cox (1978) a fourth stage should be considered, that of the consequences of the coping responses. These consequences can be both actual or perceived. The final stage is feedback, as indicated on the model, which occurs at all the other stages in the stress system.

Feedback is an important feature of the system. Where inappropriate or ineffective coping responses are evident and stress increases, acceleration of the wrong behaviour may occur

increasing damage and prolonging the stress. This can result from the effect of the psychophysiological response on the psychophysiological mechanism itself.

Howarth (1978) has extended on this concept of stress with his definition. He describes four stages, the biological, the developmental, the social and the phenomenological. The inbalance between perceived demand and capability arising because of life-style changes being far removed from natural fitness, too much of the wrong food causing obesity for example, giving rise to physical stresses. This is the biological stage. The developmental stage is where an individuals background may not have prepared him for the life he then pursues. The social aspect is where he is exposed to conflicting social values either by social pressures or even in an attempt to fulfil a particular goal. When he fails to aspire to particular goals or ideals the conflict will give rise to the phenomenological aspect.

McGarth (1976) similarly postulates a transaction model with its roots in an inbalance between perceived demand and capability.

Therefore it is decided to adopt this definition of stress, and further discussion will now follow on the concept of stress and its relationship with other factors.

2.3 Stress and its Relationships

The study of stress, in particular psychological stress and individual reaction to it, became more prominent to-wards the end of World War 1. The experiences of some individuals and their reactions to trench warfare identified, to medical men and psychologists alike, that behaviour patterns in perception, learning etc, the traditional studies were modified or intensified by emotions, urges, impluses within man more than previously considered.

Stress appears to arise whenever there is a departure from optimum conditions, which the individual is unable, or not easily able, to correct. This can occur both as a physiological and psychological factor, in fact an inbalance on one system will undoubtedly evoke a response in the other. Thus failure to adopt to a stress either physiologically or psychologically will most probably compound the situation by introducing a further stressor. Such a situation would arise in aircrew if an incident requiring mental dexterity in the air was complicated by a rising body temperature due to the flying clothing and enclosed working environment. Failure to solve the mental problem would raise the heart rate, increase respiration, raise muscular anticipation, all leading to extra perspiration and increase in body heat. The total stress induced may make the desirable response impossible.

What must also be borne in mind is that man requires stress to stimulate response and thus performance. However stress levels are individual and can therefore be high or low; his performance

can be less than maximal not only if the demand is too high but also if it is too low. Mainly the problem is where the stress level is too high but consideration must be given in any study to the negative departures from optimum.

Also, as McGarth (1970) has emphasised, stress is the result of an inbalance between demand and the organisms capacity. So not only does the immediate environmental and social conditions influence demand, but also inherent factors, training and bodily conditions have an effect on capacity. In addition Sells (1970) concluded that for stress to occur, the consequences of failure to meet the demand must be regarded as important by the person concerned.

The concepts of departure from optimum, and also Sells conclusion on personal involvement does mean there is a link between stress and motivation. This underlines the requirement that in any study of stress relationships the personality of the individuals concerned is an essential factor to be taken into account. (see 4)

2.3.1 Motivation and Stress

Motivation theories stem from the basic principle that action arises in an effort to return a situation induced by a stressor to an optimum level. The action will increase up to the limit of the individuals capacity the greater the departure from that optimum, and diminishes as it lessens. Lazarus (1966) stated the importance of motivation in any study of stress, in that he considered that stress arose when a particular situation threatened the attainment of some desired goal.

Welford (1966,1972) further emphasises the relationship in linking it to a manner of 'servo-mechanism' where positive feedback will diminish it. Stress can thus be considered to arise when motivating influences are not reduced by the individuals actions.

Anticipatory action may reduce stress by permitting the person who through training and experience learns the signs or symbols of possible future stress situations. Such anticipation will aid to reduce stress if the situation does arise. McGarth (1970) considers this process of anticipation as an operational model of threat identification.

It is implicit in a motivating action that at its conclusion there will be a reward. It is recognised that the effect of any departure from the optimum level is inversely related to the effort, difficulty or unpleasantness involved in correcting it. That is to say any motivating incentive is tempered by the consideration of the cost of obtaining it. Thus willingness to act will depend on the reward/penalty ratio. Therefore the suggestion is that stress will arise when demand exceeds capacity, in that the person cannot cope, it will also require effort or the toleration of unpleasentness beyond what he is willing to endure. This relationship also suggests that stress will not arise suddenly at a point immediately identifiable as impossible, but is a continious variable, increasing as the point of demand exceeds capacity or beyond endurance.

As in most situations whether life and death, comfortable or uncomfortable there are a number of motivating influences at work. Some are of longer influence in performance capacity than

others but overlapping . Thus success may be attained in short term goals but overall performance degraded by long term goal failures. This situation is equally stressful in reverse.

This 'optimum' level which generates arousal in the 'servo-mechanism' when disturbed or departed from requires definition. Firstly we avoid extremes of stimulation, moderate levels are acceptable. Secondly we prefer situations to follow a recognisable pattern, to be predictable. Thirdly we seek conflict, either of cognitive data or action but avoid making decisions where the conflict is severe. These three aspects are defined by Hebb (1955); in securing them we would attain an optimum level of arousal. With a moderate level, performance could be expected to be at its best; if arousal is low the individual would lack motivation; and if too high, tension and disorganisation would be evident.

Again it is emphasised that the factors involved are not only physical factors but include mental processes of assimilating data, organising the data and making any necessary decisions on it. Thus stress is generated by the number of inputs of data, the mental dexterity required and the complexity of the decisions required. In fact this presents the picture of the working environment for the aircrew concerned in this study.

Social stress can also be understood in similar terms as described in the previous paragraphs. People are another source of stimulation, uncertainty and conflict of interests. They do have an advantage of raising arousal level, which maybe the difference of being under-aroused or being at an optimum level. It has been shown by Fraser (1953) that vigilance is increased

when even only one other person is present. This could be a decisive factor in a two seater fighter aircraft, the type used by the personnel described in this study. However, larger numbers of people actually or potentially present seem often to raise the arousal level, increasing the individuals stress.

To balance this argument of groups being detrimental to performance several studies suggest that numbers are not the only significant factor. The effects are also dependant on the relationships, contact and interdependence upon each other (Haythorne 1970). In respect to an Air Force Squadron as studied it is reasonable to suggest that as a group their objectives and motives would in general be as one. Similary as a crew of two, pilot and navigator, as a cohesive and integrated pair their goals likewise would be the same giving a good balance, reducing the constraints and stress influences of personal relationships.

2.3.2 Stress and Arousal

When the brain is activated by a stressor there is a corresponding activation within the autonomic system and résultant increase in brainstem activity which facilitates easier assumilation of incoming signals (Davies and Krkovic 1965). This sensitivity is assumed to rise as the stimulus becomes more intense.

Two simplistic models of stress effects commonly used to describe the broad relationship of stress effects and arousal are

a) The Inverted - U Hypothsis

and

b) Signal Detection Theory.

a) Inverted - U Hypothesis

This model simply states that as arousal increases so performance improves until the optimum point is reached, thereafter perfomance starts to decline. But this simplistic approach does not allow for the individual variations. (1)

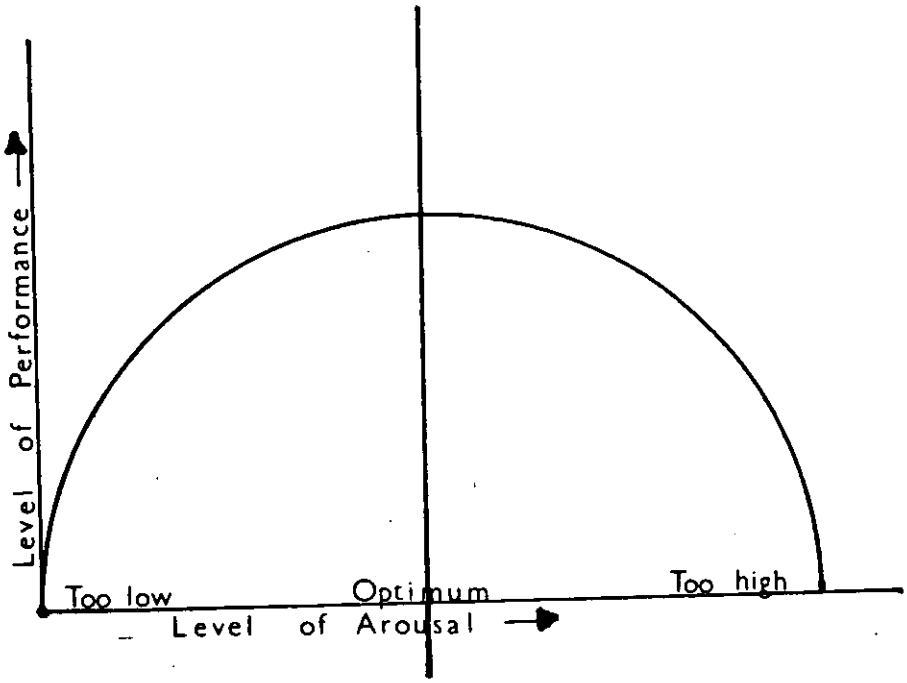


FIG 5. INVERTED - U HYPOTHESIS

The optimum point is vague and ranging. The return to the base line where arousal is to high implies a balance that is not wholly true. Varying task difficulties do not present the same pattern, this diagram does not clarify or qualify these differences.

Signal Detection Theory

b) As the name suggests this model is based on the understanding that the activated brain cells are continuously monitoring the incoming signals of arousal. These signal patterns have superimposed on them a cut-off point by the subject. When the

signal is identified above this by the subject it sets up an arousal response, anything below it is ignored. Fig 6A shows this model and the effects on the movement of the cut-off point.

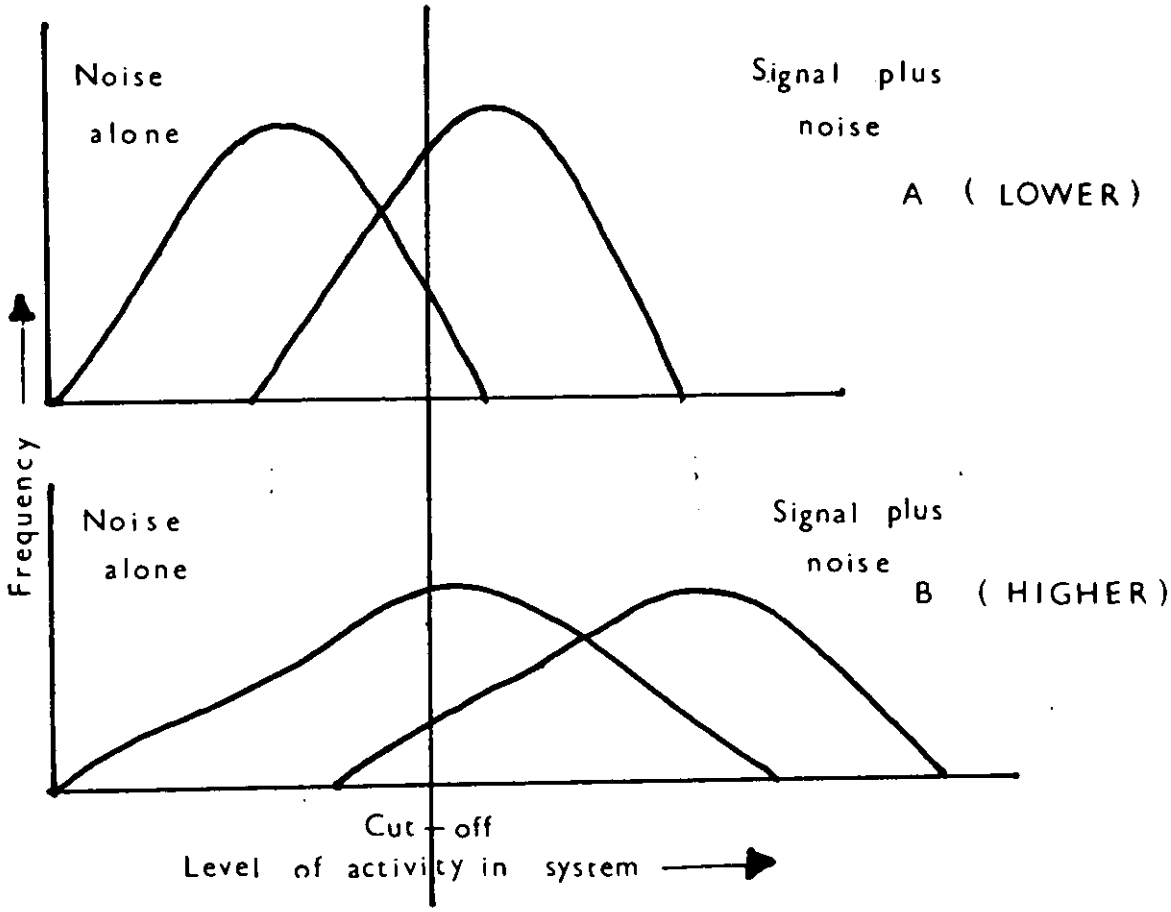


FIG 6. SIGNAL - DETECTION THEORY

Fig 6A where the level of arousal pattern is less stressful (e.g less noise) the subject responds by having a cut-off towards the right of the curve. When the stress is increased (noise increase) as in 6B the subject moves the cut-off point to the left ie responds quicker. It is suggested that the 'cut-off' point moves to the left in this way due to the increased activation in the brain making it readier to fire and activate any necessary systems. Progressive movement to the left would be indicative of over arousal and similarly movement of the cut-off point to the right would suggest under-arousal. As stated by

Welford (1973) above optimum he is overactive and errors are generally those of action. [illegible] (A) [illegible]. Whereas (A) below optimum, the subject is underactive and errors are mainly those of omission. There is little detailed study to support this theory but as Welford (1973) similary said Monotony and (1) boredom, resulting from under arousal, tend to produce an inert type of performance and drowsiness, while over arousal often result in hasty and ill considered actions.

2.3.3 Stress and Difficulty of Task

Performance on some tasks seen to be enhanced by high levels of emotional excitement, while in others it has been shown to diminish. Taking this further it has been reported that performance on a more complex (maze) problem has been adversely affected by anxiety. (Mataroyyo and Matarayyo 1956)* also (Taylor (2) and Spence 1952)* Yerkes and Dobson (1908) found that the optimum level is lower for difficult than for easy tasks. This effect is known as the Yerkes - Dodson Law.

Therefore, it is suggested that difficulty of task has a relationship with stress in that incentives, whether rewards or of punishment, tend to raise the level of arousal.

Other studies by Wechster and Hartogs (1945)* on fine-motor skills (3) showed them to be adversely affected by anxiety. Also on complexity of task and stress Miller (1960)* found significant (4) relationships between emotional stress and consistency of competitive performance. Poor competitors exhibited less

* (MASON 1968)

emotional stress than did good performers.

2.3.4 Stress Strategy

Various studies have found that when 'stressed' individuals seek both consciously and unconsciously to remove overload rather than cope with it. A classic study is that by Davis (1948) concerned with artificial aircraft cockpit studies. This was among the first laboratry studies using an aircraft simulation. The experiment found that subjects engaged in instrument flying i.e. no use of spatial features external to the cockpit., towards the end of the flight started to ignore instruments peripheral to the main task.

Other evidence of this strategy is the abandonment of tasks when they become too difficult, when abandonment is not possible the subject often sucumbs to aggression towards its source.

Stress engendered by under stimulation also bring about strategies to deal with it. Where experiments were geared to reduce sensory perception or stimulation subjects have sought stimulation, even from objects or data which would be considered of little interest normally. (Zuckerman and Haver 1965). Such diversions or stimulations are easily seen in people who are bored with the tendency to tap fingers or feet, or whistle. At a social level, boring monotonous work is often cheerfully borne if there is company and therefore the facility for conversation.

Individual Differences and the Effects of Stress

The factor of individual difference which decides the degree of stress effect most noticeably is individual personality. Those who display high anxiety traits in personality as a rule are more disturbed by stressful conditions and have greater difficulties in coping in new situations than do less anxious persons (Parsons, Phillips and Lane 1954)*. Baker (1961)* concluded that stress inhibited performance of high anxiety performers but aided performance of low anxiety subjects. Individuals have varying degrees of resistance to distraction thus responding differently.Individuals having different levels of proficiency often react differently to a stressful or motivating condition. Gates (1924)* identified this difference in that proficient students performed less well in front of an audience.

Extroverts versus introverts is another common comparision in their relationship with stress. The introvert is restrained and sensitive and tend to be self driving. As would be expected they perfrom best if not driven hard, this is consistent with the inverted - U relationship of Figure 2A. Extroverts are the opposite, they seen to seek normal stress inducers, noise, social contacts, active stimulation, giving the impression that without such stimulants they would be under aroused. It is under such pressure that they perform best.

Another possible difference of stress effects between individuals is reported by Bridges (1971). He considers somatotyping an important factor relating to stress effects. He found muscularity a beneficial relationship in stress control. Those

*(MASON 1968)

classified as linear showed significant stress responses which tended to impair their performance.

General evidence shows that an above average level of excitement aids learning and performance in most motor tasks. In addition high levels of arousal are considered advantageous for performance in gross motor activities e.g. speed, strength, endurance. However, these high levels will interfere with performance involving fine muscle movements, co-ordination and concentration and learning motor tasks.

2.3.6 Stress Control

The overall impression of individuality and the differences between individuals in relation to stress gives a positive direction in which stress can be modified. Fundamentally the problem is to match the individual to his task. This requires making him physicaly fit and mentally fit. The boundary between each does not exist, they complement each other.

Also implicit in this approach is the requirement to discover individual personality requirements to avoid wasting or destroying talent. Furneaux (1962) reported a study on first-year engineering students exam results. They were identified as introverts and extroverts; results of the extroverts were much poorer than the highly strung introvert. A similar study was done by Killingworth (1972)* with exactly the opposite conclusion. ① It was concluded that the latter group of extroverts were put under more pressure than the ORIGINAL group and as extroverts ② thrived on the pressure to produce better Results. Such pressure obviously worked to the detriment of the introverts identified in Killingsworths study. ③ This emphasises the requirement to identify individual needs to gain the best experience.

Some individuals actively seek stress related activities of which flying aircraft maybe considered such an activity, particularly military flying. However many experts concerned in the study of stress and its related effects are unanimous in stating that there is a need to relieve tension at frequent intervals. Michael (1956) proposes exercise will improve adaption to stress, ④ giving a 'learned' process. More proposals for mitigation of stress include positive health education (Macdonald-Wallace 1978) ⑤

*(WELFORD 1976)

on similar principles Welford (1976) suggests stress training suited to individual requirements would be a positive solution.

In summary it is considered adaption to stress within indiviudal limits is probably possible but like capacity these limits will be related to individual factors of age, experience, well-being, environment etc.. It must also be remembered that some stress is necessary to produce the optimum level; only when the stress is too high is it detrimental. In addition stress can be caused by underloading as well as over-loading, thus as experience increases, if the task remains stationary, boredom and dissatisfaction will develop. Fundamental to any concept of stress is that the perception and effect of stress is different for each individual, as is his strategy and inherent ability to cope with it.

By moving now to a description of the aircrew working environment in the F4 Phantom jet fighter, and the many roles and tasks they fulfil in it, the objective is to identify potentially stressful areas both perceived and defined. These evaluations will be made generally from normative values and anecdote by the aircrew themselves. Following chapters relating the results of the physical and psychological factors of the aircrew hopefully will underline these normative values. Based on these it may be possible to make judgements on the relationships of stress, health and fitness. In addition it is hoped to discover how they as a group adapt and cope with the stresses inherent in their job.

2.4 Aircrew Stress (Potential and Perceived)

2.4.1 Introduction

The working environment of the aircrew concerned in this study is the £2.5 million Phantom F4 Fighter Bomber with running costs in excess of £1000 for each flying hour. It requires a crew of two, a pilot and navigator, each with their individual and specific task to fulfill. The pilot has the primary reponsibility of 'captaining' the aircraft, using his skills to fly the aircraft safely, efficiently and accurately. The navigator assists him in this role by monitoring instruments identical to the pilot, giving expertise in navigation permitting precise and efficient flying and in addition he operates the radar used to track and fire the aircrafts missiles. As a team they operate the aircraft as a weapon platform in its many roles both offensively and defensively.

Common to both pilot and navigator is the necessary paraphernalia of jet flight. The inital layer of clothing is the cotton vest and long johns, now generally replaced by an all in one suit with an inner layer of acrylic pile affectionately known as a 'bunny' suit because of its pantomine appearance. Over this is worn a 'G' suit, a series of air bladders held together with laced webbing and worn on the calves and thighs. When flying is in close proximity to or over the sea as it is at Leuchars the outer flying suit is the rubberised immersion suit complete with rubber-sealed holes for the arms and head. The feet are secured

in permanently sealed rubber socks attached to the legs. The clothing is generally regarded as constraining and being necessarily water-tight, over-heating and discomfort are common. Some unofficial modifications of underclothing frequently occur in an attempt to minimise the rigidity and discomfort generated by the clothing and ancillaries.

These, ancillaries consist of the infamous 'Mae West' lifejacket, black hide flying boots and a pair of pigskin charmois gloves. To complement these he wears on his head a bulky piece of headgear called the MK3 helmet. The clothing is heavy, restraining and uncomfortable to wear for a continuous period of duty. In its defence it has been designed for safety and protection of the individual in the high risk area of normal peacetime flying to the knowingly hostile environment of survival in both peace and war. The recent introduction of the combined harness with integral seat and parachute fitments has removed another ancillary which was a body harness worn separately, and requiring additional manoeuvres to attach oneself to the ejection seat.

The stresses generated by the personal clothing and equipment are constantly monitored by those involved in their design and modification is constantly in progress. Their problem is the constant question of compromise between safety and yet functional. The MK3 helmet is an example of this problem, individualy formed to each aircrew members head, variety of safety and sun visor, internal radionics but claimed generally by aircrew to be heavy and prone to obscure all round vision. To overcome this many continue to wear the old MK1 helmet based on a

1950's design of separate inner and outer helmet; an inner material helmet with radionics and an outer fibre-glass shell.

The wearing of the older model is recounted to give better mobility of the head giving better all round vision (vital to fighter aircrew) and in addition lighter and therefore more comfortable to wear.

The aircrew can therefore even in the basic aspect of clothing be considered to be involved in attempting to reduce the influence of stress, in particular physical stress on successful fulfilment of their task. What is also interesting is that some of these modifications such as wearing the older mark of helmet are known to be less safe with possibly consequencies of life or death and yet within the group they are socially acceptable. The occasional unfortunate fatality found to result from such modifications has what only seems to be a momentary effect, and then life continues as before.

In my role as survival training officer I had the opportunity to call at relatively short notice a survival exercise in the barren remoteness of the Scottish Highlands. This would invariably be during the winter months and would involve the randomly chosen aircrew to be advised on completion of a normal aircrew sortie their nomination. They would then without personal preparation be flown by helicopter to a remote site where for 24 hours they would survive on the contents of a survival pack identical to the one on their aircraft type. For shelter and protection they would improvise with the use of their parachutes, a equipment reality they would have in such a situation. The point of

relating this situation is that when rumour of such exercises being imminent where being discussed the aircrew were concientious in wearing the proper flying clothing. Such attention to detail was lax under normal everday flying situations. This does provide an example of individual perception giving rise to a stress situation because in comparision the careful monitored and controlled survival exercise at most could only result in discomfort but ejection into the sea ill-prepared could result in death. Yet some individuals could not perceive this everday risk whereas others could and reacted conscientiously.

The pilots position in the front cockpit is relatively comfortable, with a big seat and good forward and all round vision through the plexiglass canopy. His instruments are crowded but positioned well to permit him to scan easily necessary dials and reach the stick and throttle with minimum adjustment. The navigator flying (in tandem) in the back seat, is not so fortunate. His instruments are positioned around him and about a foot in front of him on a console which extends upwards almost to the roof-line. This obscures his forward vision to the point that is all but non-existant. Limited forward vision is possible down two narrow tunnel openings on either side of the central mass, permitting him to view the extreme edge of what is in front. Consider the accepted stressful situation of landing on the unfortunate navigator. His duties demand the monitoring of the instruments indicating speed, RPM, attitude etc, replicas of the pilots, but deprived of the

physical feedback through any controls or vision externally, of attitude and distance. As will be demonstrated by heart-rate recordings (see 4) it is understandable why in many cases stress exhibited using heart-rate criteria is higher in many navigators than their accompanying pilots. This is identifiable in the manoeuvres of take-off and landing.

By the time either aircrew attain the operational task of flying the Phantom F 4 they have already undergone over 2 years of high pressured and stressful training. Both pilot and navigator each learn in their specific training pattern how to handle and assimilate information quickly and selectively. Each is graded through a mixture of both faster aircraft types, and also in their more demanding roles. From basic flying attitudes to the more complex aerobatics of potential combat roles and configurations. The navigator similarly learns his trade rising from the sedate tracking procedures over normal terrain to the high speed interception control necessary in air-defence using radar-techniques demanding 3 dimensional appreciation of a flat cathode-tube. Therefore aircrew arriving on an operational squadron such as the two squadrons involved in this study have not only exhibited aptitude but have in doing so been successful in management of the stresses inherent in the task.

The role of the two squadrons studied is the general role of air-defence. This involves protection of vital installations such as airfields and also centres of population. In addition they protect shipping and other aircraft involved in other roles. To achieve this it may be necessary to take an offensive posture and seek and destroy enemy aircraft or to provide patrols in a

defensive posture as an act of deterrence. The squadrons being discussed portray all those roles admirably in that their geographic location makes them front-line defenders against the potential enemy.

In looking at their task in more detail in areas of interception, missile firing practices, inflight refuelling, ground controlled approaches (GCA's) and air-combat a greater appreciation of their potential stresses and their perceived stresses can be gained.

2.4.2 Interception

In describing this role we will base the scenario on a common task at RAF Lauchars, that of Intercept Alert Force (IAF). This involves two crews with two fully armed aircraft on 24 hour alert, 365 days a year. Each crew does a 24 hour watch aware that they could be called on anytime during that period to react to a call from the Sector Control to intercept, identify and if necessary destroy an aircraft not recognisable on radar. The watch is maintained from the Q sheds, twin corrugated hangarettes which are self contained for both eating and sleeping. The intial potentially stressful factor and often perceived one is that of boredom through under activity.

A diet of continual snacks via a micro wave oven and a series of videos interspaced by a variety of 'racy' magazines often heighten rather than allieviate this problem. Strategies to maintain a reasonable arousal pattern involve frequent but unnecessary checks of the aircraft and armament or pre-positioning of clothing or equipment to facilitate a rapid start-up. It is by nature a waiting game, hoping the Russian will probe deep enough to generate an alert.

In the early hours, 14 to 16 hours into the duty the telebrief may speak out giving the information on heading, speed and height of a possible intruder. Physiological response is all but immediate, psychological lags a little behind. Cold water on the face maybe introduced as a stimulant. The crew when scrambled are airborne with 3 mins. This involves the multitude of pre-take-off checks of instruments and controls and the assimilation

of external inputs from air traffic control and Sector Control. Training makes much of the whole process automatic but minor but important checks and actions do occasionaly get overlooked. The simple but necessary locking of the leg gaiters to the seat has often been overlooked and in any ensuing ejection the individuals flaying legs would suffer severe dislocation. Simple situations such as these can arise from overload on the individual either of information or arousal.

Pressure is on the aircrew to make the interception and they work as a team to-wards this end. Controlled by Sector, who give relative positions of the two aircraft shown on their radar are also aware of any mistakes in intercepting by the Phantom crew. Pressure is constant until the aircraft is sighted or it turns for home making a chase not only futile but sometimes impossible. Even when intercepted all pressure is not necessarily relieved. Intruders have been known to suddenly blast out a high powered beam of light into the Phantom pilots eyes ruining night vision, (1) and potentially dangerous. Also it is not unusual for the intruder to make sudden deviations from track or avoiding manoeuvres to shake-off an interception. In addition, at the back of the aircrews mind is that both he and the intruder are armed and when is brinkmanship defined to have stopped.

2.4.3 In-Flight-Refuelling

There is a natural progression from interceptions and maintenance of combat-air patrols (CAPs) to the situation and requirement for in-flight-refuelling. By drawing fuel from a tanker aircraft via a trailing hose the range and endurance of a phantom is enhanced.

On the phantom the refuelling probe is positioned on the right side of the fuselage just behind the pilots vision. By placing the aircraft in the proper configuration of angle and speed behind the tanker, the probe enters the basket opening of the trailing fuel line and fuel flows into the phantom.

The manoeuvre requires absolute concentration on the job in hand to achieve success. When this concentration is absent trouble in re-fuelling will ensue. The pilot throughout the whole procedure relies on peripheral vision and the navigator can assist with his limited vision on the position of the basket. Instances have been recounted of the stress and pressure felt by what they state to be an automatic and unreasonable feeling of being under scrutiny. This can be from either the tanker crew or even the individuals contemporaries flying in formation with him. But concentration goes and resultant failure increases the stress influence, requiring total break-off before trying again.

Add to this the stress induced by the situation of being positioned far from land, short of fuel, and weather conditions marginal giving difficulty in finding the tanker. These are situations which occur regulary during the dark winter months north of the Faeroes.

2.4.4 <u>Missile Firing Practices</u>

Missile firing practices or armament practise involving live ammumition has an immediate response on the arousal state of aircrew. Opportunities to fire live missiles are extremely few due to the high cost involved. This often means random selection of aircrew, chosen by Command external to the unit, to test the

readiness state of that squadron. Pressure from all sides is then evident to ensure success. Command are looking for maximum efficiency with due attention to procedures and techniques. The squadron executives are also relying on absolute success, anything less will reflect badly on them. In addition the individuals peer group are watching with envy where any failure will result in sharp criticsm.

Under these pressures the crew must attempt to fly a perfect missile profile, a technique and procedure practiced regularly in the simulator. To keep within safety margins and arcs of fire flight profiles of height speed and direction must be exact. Radar control on the ground is maintained throughout. In addition to arm a missile involves the removal of a number of fail safe procedures and it has been known through pressure for exactitudes and the arousal of a live firing for points to be missed in those procedures. The shame of such a misfire is borne not only by the individual crew but also by the squadron.

Gun practice is surrounded by the same pressures. Both situations are the nearest practical evaluation of individual and squadron effectiveness in the task for which they train. Thus superimposed upon individual pressures are group pressures all which add up to the many social pressures within that group. At Leuchars with two squadrons with similar roles any deviation is quickly noted and critised by the other. This heightens and accentuates stress at both the individual and group level.

2.4.5 Ground Controlled Approaches (GCA's)

A ground controlled approach is where the pilot flies his aircraft on instruments alone with no external visual cues, and making flight corrections in response to the ground controllers commands who watchs the approach on radar. The situations demanding this form of approach and control are normally when weather and cloud has caused limited visibility, obscuring visual sighting of the airfield. The decision to make such an approach can be self-initiated by the pilot or air-traffic control can use their own judgement to initiate it.

Instrument flying demands considerable concentration, and self-control is necessary to avoid the impluse to look-out for visual cues. As stated such flying situations are normally through 8/8 cloud and visual flying could precipitate disorientation and disaster.

The controller surveys the flight attitude on two radar screens, one shows the aircraft in elevation relative to the runway threshold known as the glide slope the other a directional view showing right or left of the runway. To fly an ideal glidepath the aircraft must maintain not only a good directional centre-line on the path but height must be lost at a specific rate. This requires frequent adjustments of both the aircraft attitude and speed by moving the throttles and controls. Designated break-off heights are given by air-traffic control. At these decision heights, if when taking visual control the pilot cannot see the runway it is standard procedure to overshoot and make another another GCA.

GCA's can occur at the end of a long sortie, in a malfunctioning

aircraft or just for guidance through a heavy traffic pattern. Any of these situations would be stressful on their own but it is not uncommon for two or more of them to occur to-gether. Add to this the pressure of removing visual cues other than instruments, and with talkdown your destiny is in some other persons control.

Both psychological and physiological stresses are evident and can be identified in the heart rate response monitoring taken during this flight situation, both real and simulated. (see 4)

2.4.6 Air Combat

In this role both pilot and navigator are working at their limits, physical and mental. The aircrafts radar has the search capability of looking not only in an arc but also up and down. The navigator monitors the screen transforming identifiable blips into 3 dimensional pictures of height, speed and direction. He relates to the pilot an intercept pattern of speed and direction, the objective being to place the aircraft on the tail of the opponent. This gives the heat seeking heads on the missile its optimum position for success, up the jet pipe. When missiles are primed and locked-on by the navigator the best distance to fire is produced by computers forming concentric circles on the blip on the radar. An audible growl is also reproduced in the headphones of the aircrew. When practiced in mock combat, to record both missile and gun kills a camera is tripped when the pilot presses the normal fire trigger.

This simplistic description on the fundamentals of air-combat omits initially the skills and physical effort to place an aircraft on the tail of another. Most combat situations after the search and acquisition phase result in some form of aerial ballet. Each pilot mentally and physically working to better the other. The thought of death by being shot down by the other in what is basically a game, may not exist but the risks are still high. Aircraft weave and climb, roll and turn at high speed as for real, always with the threat that things could go wrong. Add to this the physical stress of high G turns, acceleration, inversion and momentary disorientation and individual upper

limits must be approached and tested.

The mental dexterity of the aircrew is constantly under pressure, anticipating, calculating and then initiating countermoves. Pride is a strong motivator pushing the individual to call on every possible physical and mental resource. To 'kill'provides exhiliaration, to be killed results in self-criticism and resolve to do better next time. Low level combat, that is high speed chase at low level, over sea, hill or dale only accentuates the stresses of high level combat,. Parameters of action are more constrained immovable objects such as pylons, transmitters and hills sharpen the aircrew perception to the stresses of flying. The air combat sortie leaves aircrew physically and mentally drained, a role which exemplifies the totality of their craft.

2.4.7 The Simulator

It is relevant for this part of the discussion to provide a picture and description of the simulator and the feelings of the aircrew to-wards it. In measuring work intensity and stress it provides a controlled if not ideal situation. The artificialites of the simulator are difficult to eradicate but it does serve a vital training function .

The simulator itself is a phantom cockpit positioned 15 feet off the floor. The complex system of hydraulic stilts upon which it sits permits the platform to tilt, rise, sway, pitch and rock, simulating the variety of manoeuvres experienced in the air. The room in which the simulator is stationed is painted matt black. The cockpit only has forward vision for the pilot, therefore with lights out and a moving visual picture projected on to a white

screen in front of him a number of flying situations can be reproduced. This permits situations of take-off, low level navigation routes to targets, attack profiles, GCA to land all on a visual picture. The whole complex procedure, external and internal to the simulator is regulated and monitored by computer. In a separate room the simulator staff positioned at a semi-circular console operate the inputs for any particular training sortie. The console holds replicas of all the instruments in the cockpit, both pilots and navigators. Also it has warning lights which indicate reponses and checks being carried out by the aircrew. By any of these switches the simulator staff can reproduce a world of havoc for the aircrew, stimulate the adrenalin and bring pressure and thus stress into their lives.
In novice aircrew the limits of this induced stress are low and easily reached, but like most things experience and training raise these limits. This results in the more experienced aircrew speaking of boredom and the artificialities of the simulator. But there is constant updating and ammendment to procedures which does not allow for complacency. The opportunity is always their to push the boundaries of individual limits further away. As stated by one pilot "Yes, I know the answers already, but the questions come from different angles and at different times."
Phantom crews are required to carry out a minimum of one simulator session a month, preferably two. It provides the opportunity to practice the normal such as missile profiles, GCAs and interceptions. In addition it permits practice of the extremes not possible in real flight such as double-engine

flameouts, instrument failures and many others. It trains aircrew to imprint coping responses which then become automatic, minimising stressful influences if it occurs in real-life. When inputs are plausible realism is maintained, and the sortie has real value. Even the majority of experienced personnel consider the simulator sorties as valuable and on occasions when overstressed can only cope by simulating ejection.

In summary the many roles of the phantom aircrew involve them in high risk. Continual practice and training will not remove this risk but it does equip them with strategies with which to cope with it. They undergo stress both physical and mental in the normal pursuance of their tasks. These stresses are environmental, social, psychological and physiological. Training and experience seem to be major determinants in how influential the potentially stressful and perception of stressful situations are on the individual. By looking at the fitness and health factors in addition to the psychological characteristics of the group it is hoped to identify other possible determinants influencing a suitable coping response.

Bodily exercises are to be done discreetly;
not to be taken evenly and alike by all men.

Thomas A Kempis (1426)

3. Fitness and Health Measurement

3.1 Introduction

Most of the present methods of evaluating fitness in military personnel has centred round the work by Balke and WARE (1959) and its modifications by Cooper (1970) in the form of a set run and time relationship giving a $\dot{V}O2$ max. Its main attraction has been its economy in use demanding only a measured distance and a stop watch.

The British Army 'Physical fitness' tests rely heavily on the timed run evaluation as most of their tasks have a heavy physical component. The other two services, the Royal Navy and Royal Air Force have in the past attempted to mirror this approach to physical fitness evaluation with little success. The uniformity of task in the Army may make such an approach relevant, even desirable, but in the Royal Air Force the variety of occupations and needs, negate this approach.

One main objective of this study in addition to the appraisal and relationship of health, fitness and stress was to design and evaluate a suitable Personal 'fitness test and health evaluation for individuals, and IDENTIFY their needs specific to their task. To choose only a set run system as the method of identifying cardio-vascular efficiency was discounted for the following reasons.

Coopers Table of fitness categories indicates that running 1.5 miles in 12 mins could place the individuals in the fair, good or excellent category; the range being from 40 to 52ml/kg. The standard error of $\dot{V}O2$ max prediction would be at least 14%. Katch et al (1973) stated that distance runs were uncontrolled

exercise tasks where pacing errors could result in inconsistencies in the indivduals true aerobic capacity. Similar criticism was cited by Jackson et al (1981) in a recent study who found that motovation is a major factor in the validity of distance runs for measurement of aerobic capacity. The study also revealed a possible influence of the relationship of anerobic and aerobic endurance in such tests.

To evaluate $\dot{V}O2$ max it was decided to use a computer programmed version of the Åstrand Rhyming nomogram inclusive on a Tunturi cardiotester with constant heart monitoring. Shephard et al (1971) have shown this method to have an error of around 10%, statistically more attractive for field work than Coopers timed run. A main advantage of this form of evaluation is that it can along with the other measurements proposed form an educative framework of fitness and health counselling giving privacy and eliminating the connotation of athleticism pervaded by the various modes of timed runs.

The need to choose a fitness test with individual appeal was identified by Eichna at al (1944) in some valuable wartime studies. They concluded that motivation - the "will to do"- maybe an exclusive determinant of fitness scored by the more physical tests such as timed runs, the Navy step test, and the Harvard step test. Also concluded was the less scientifically reliable conclusion that an officer who knows his men is better able to evaluate their fitness than any fitness test yet devised. Appraisal of military fitness has, as intially stated, tended to restrict itself to identification of cardio-respiratory fitness

and little else except possibly cursory referal to standard weight charts. This chapter will describe an evaluation which broadens the appraisal to include body composition and health parameters. Although much literature has shown fitness correlates poorly with health they recognise that they do influence each other. Health appraisal has also shown to be an excellent motivator to individuals to modify their lifestyles and improving their potential fitness (Allen D.W. 1980). This broader approach is necessary in the Royal Air Force because unlike the Army where cardio-respiratory fitness is both desirable and relevant to the majority of their tasks, the Air Force is less physical, and more sedentary in nature where, even for most ground crew, strength would be a more desirable factor.

Health measurement or health hazard appraisal is not new and is described fully in a text by Robbins et al (1970). To measure the health of the aircrew in this study eight actuarilly scored risk factors were used. Namely gender, age, inherent factors, blood pressure as four 'inherent' factors and % fat, smoking, exercise (Pulse $\geq$120 bpm) and stress which are considered lifestyle factors. The summation of each individual score would within a range identify a risk level or health status.

This form of appraisal system as concluded by Colburn at al (1973) also has other advantages:

1). It helps people to understand better the nebulous idea of risk taking behaviour and the fact that how we live often determines when we die.

2). It demonstrates the quantitive nature of risk taking behaviour and that individual risks add to or compound one another.

3). It makes health hazards personally relevant. It helps the individual to realise, "It can happen to me".

4). It indicates the relative importance of health hazards so the individual can choose which ones he or she should do something about and where to start.

5). It conveys a sense of immediacy and urgency.

6). It provides a promise and a measure of improved risk if some of the factors are altered.

Through evaluation the individuals 'strengths' and 'weakness' can be identified and through personal consultation and the use of computer stored exercise lifestyles adapted and inspired by work compiled by Larson and Michelman (1973), a self-tailored health and fitness exercise lifestyle can be given.

These exercise lifestyles although not part of this study do provide the facility for the individual to have a programme to follow and direct any necessary lifestyle modifications. This ensures individual remedies are task specific.

3.2 Methods

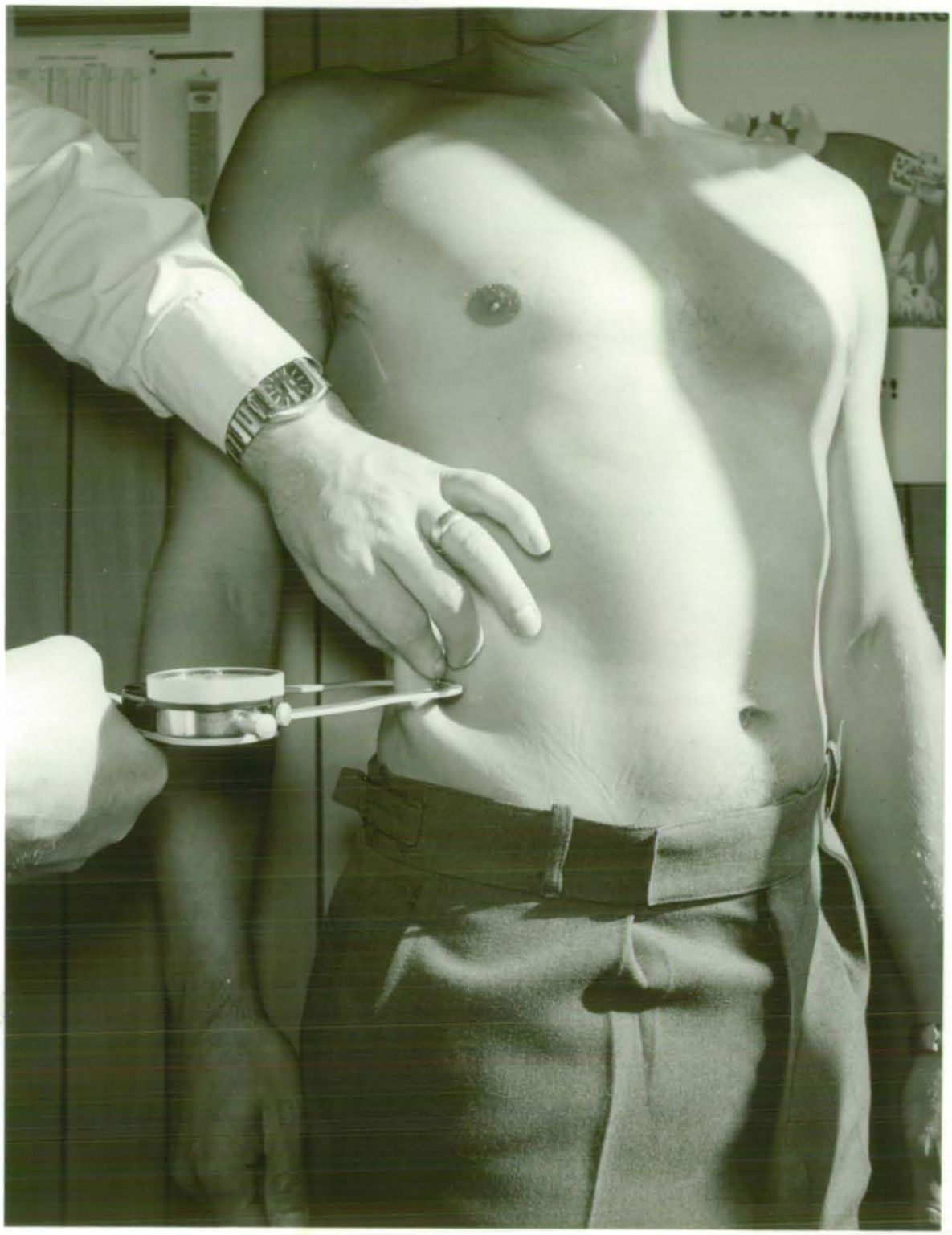
Eighty two aircrew (74 fast-jet, fixed-wing and 8 rotary wing) participated in the study. Their physical characteristics were height 180.42 ± 5.72 cms, weight 77.43 ± 9.83kg and age 30.71 ± 5.53 years.

Each individual answered the health status questionnaire (fig 7) based on standard actuarial risk factors and assigned from the total score to a risk category, health status. Resting blood pressures were taken in a supine position using an electronic digital B.P. measuring unit (TM 101 accuracy ± 3mm Hg, Pulse ± 5%) giving systole, diastole and resting pulse read-outs.

Harpenden skinfold calipers were used to determine skinfolds over the biceps, triceps (midway between the olecranon and acromion), at the inferior angle of the scapula, and over the iliac crest along the lines of Linn. Two trials minimum were taken to ensure an average of less than on millimeter discrepancy. The summation of the four reading gave the per cent body fat using the table, illustrated at appendix 1, derived by Durnin and Womersley (1974).

Stress evaluation was based on subjective evaluation of their daily stress level, low being normal everyday level, moderate where an individual felt easily overhelmed by daily stresses, at times unable to relieve it, high stress is where the individual required medicinal aid to relieve it. An objective but as yet unvalidated test of stress level developed in the use of the questionaire was when asked by the subject how he could evaluate his level, if described as the ability to smile spontaneously indicated low stress, if under moderate stress it was difficult to elicit a smile consciously or unsconciously. This statement although not scientifically validated did correlate highly with both how the subject judged himself and how he scored in the Rahe and Holmes questionnaire which each subject was given. The questionnaire was a modified version and is illustrated as appendix 2, page 164.

Height and weight were determined by the use of a stadiometer and clinical scales, respectively. Using the weight tables collated by the Metropoliain Life Insurance Co., (1959), used exclusively throughout the Air Force by medical officers, the deviation from



2. Skinfold measurement on side of waist.

the norm was identified as a positive indice above the norm, or negative indice below the norm.

FIG 7 HEALTH-STATUS QUESTIONNAIRE

NAME Flt Lt I FLY DATE 3 – 4 – 82

	Sex	Age	Relatives with Strokes or Coronaries	Blood Pressure	Fat %	Smoking per Day (Cigarettes)	Exercise – Pulse more than 120	Stress	
	① Female ③ Male ⑤ Stocky Male	① 18–29 ③ 30–49 ⑤ 50–69	① One over 60 ③ One under 60 ⑤ Two or more under 60	① Systolic 140–160 ③ Diastolic more than 100 ⑤ Systolic more than 160	① ♀16–19 ♂14–18 ③ ♀20–25 ♂19–24 ⑤ ♀26–31 ♂25–30 ⑦ ♀32– ♂31–	③ 1–5 (Pipe Rule) ⑤ 6–19 (Cigar Rule) ⑦ 20 or more	① Regular (Every Day) ③ Occasional (Once per Week) ⑤ Sedentary (Once per Month) ⑦ Slothfull (Once per Year)	① Low ③ Moderate ⑤ High (Requires Drugs)	TOTAL
SCORE	3	3	0	0	1	0	3	1	11 x

	Very low risk	4–7	Below average	13–17	Above average 25–30
x	Low risk	8–12	Average	18–24	High risk see G.P. 31 and above

The measurement of $\dot{V}O2$ was done submaximally on a Tunturi cycle ergometer, friction pad braking system, ensuring the seat adjustment caused the subjects knee to be slightly flexed with the ball of the foot resting on the pedal at the lowest point in revolution. Constant heart rate monitoring was done using the Tunturi cardio-tester which also included the Astrand Rhyming nomogram computer programme. All subjects started at a work load of 100w at 50 pedal revs per min. This was increased by 25w at 1 min intervals to 200w max on the fourth minute, the fifth and sixth minutes of work were observed for a steady state where the difference was not more than 5 bpm. This being achieved the maximum reading was taken and the test stopped. The information on heart beat and work were than processed by the cardiotester.

3. Indirect Ergometer test with Cardiotester.

If during the test any increase in load raised the heart rate past 150 b.p.m.no further increases in load were made and the test continued for the full six minutes observing the test protocal as before (Astrand 1960). The mean value was betweem 130-160 bpm for all individuals who participated in the test.

To standardize the submaximal test ten subjects (5 aircrew and 5 physical training instructors) volunteered to participate in a submaximal direct measurement of oxygen uptake to compare with their indirect result. The exercise was performed on a Lanooy cycle ergometer, electro-magnetic braking system, adjusted for efficient pedalling. The expired gases were collected and analysed for oxygen and carbon dioxide using a paramagnetic oxygen analyser (Servomex OA 540) and a Beckman, LB2 CO2 analyser respectively.

Each unit was connected to a 4 channel pen recorder (Devices Ltd) These records permit the relationship, heart rate to oxygen consumption, to be calculated by the linear curve and hence its regression equation. The system is calibrated by passing a known gas mixture through a wet gas meter. (A.Wright and Co.) to give a constant reading. The work loads for the exercise were increaded progressively from 30W by 20W increments for a period of 12 mins. As in the indirect method the Astrand age correction factor was used to give the final measured VO2 max.

FIG 8. DESIRABLE FITNESS INDICES

MALE (years)	AEROBIC POWER (ml/kg)	FAT (%)	HEIGHT (Cms)	WEIGHT (Kg) SMALL FRAME	MEDIUM FRAME	LARGE FRAME
			(5' 0") 153	50 (112lbs)	54 (120lbs)	59 (130lbs)
			1" 155	52 116	56 123	61 134
			2" 158	54 119	58 127	62 137
18–29	43	13	3" 160	56 122	59 130	64 140
			4" 163	57 125	60 133	65 144
			5" 165	59 129	62 136	67 147
30–39	42	16	6" 168	60 133	64 140	69 152
			7" 170	62 137	66 145	71 157
			8" 173	64 141	68 149	73 161
40–49	40	18	9" 175	66 145	70 153	75 165
			10" 178	67 149	72 158	77 169
			11" 180	69 153	74 162	79 174
50–59	37	19	6' 0" 183	71 157	76 165	81 179
			1" 185	73 161	78 171	83 184
			2" 188	75 165	80 176	85 188
60–69	34	20	3" 190	77 170	82 181	88 193
			(6' 4") 193	79 (174lbs)	84 (185lbs)	90 (197lbs)

Aerobic power – Thompson (1976, $\dot{V}O_2$ 180) Fat – Durnin (1975)
Weight – Metropolitan Life Insurance Co. (1959).

3.3 Results

As would be expected in two very active operational squadrons the average age was around 30 years, 30.71 ± 5.53 years. Therefore it is considered that inherent fitness would be a major factor in the reason for in general a very acceptable level of fitness. Maximum oxygen consumption of the aircrew at 46.5 ± 9.05 ml per min per kg body weight ($ml^{-1}/Kg^{-1}/min^{-1}$) shows a good level of cardiovascular function particuarly when considering a 1.5 mile aeroblic test run in 12 mins equates to approximately only $40ml^{-1}/kg^{-1}/min^{-1}$. A paired t-test was done on the group results from the predicted and directly measured ergometer tests but no significant difference was found (level of significance $P < 0.05$) The mean weight of the total group at 77.43 Kg ± 9.83Kg does not indicte a large number of overweight personnel. A clearer indication of this level of healthy weight is the group mean %

deviation from normal weight indices of 3.46 ± 6.7%.

An influence of the sedentary nature of their occupation both on the ground and in the air is shown by the total skinfold mean 46.6 ± 11.71 mm. With reference to Durnim and Wormsley table, see appendix 1 page 163, this revealed a body fat mean of 19.12± 3.65%. When analysed for the % deviation from normal fat indices the results demonstrate the problem 30.81 ± 21.26%.

The relationship between lean body mass (LBM) and aerobic function was highly significant ($P=<.01$) Similarly a highly significant relationship was identified between the ponderal index (WT/HT^2) and $\dot{V}02$ max of the group ($p<.01$)

The systolic blood pressure for the group was 129.25± 10.84 mmHG and diastalic pressure 80.67 ± 9.90 mmHg. Less than 2% of the group had pressure readings which would be considered outside normal limits.

The health status of the group as evaluted by the questionnaire gave a below average risk status 12.67± 3.33. The groups disposition to exercise (at least once per week -pulse more than 120 bpm) was not high at only 51.2%. Smokers among the group, although in the minority, were still high at 24.39%. These two factors were the main cause of individuals being in the 'Below Average' (13-17) and 'Average' (18-24) risk categories rather than 'Low risk' (8-12).

Table 1 identifies a number of trends which are well established in literature with respect to many groups. Notably agreement with studies which showed maximum oxygen consumption generally decreases with age. The same is true of the increase in body fat with age. The inconsistency in the results when analysed as %

deviation of body fat being higher in the younger range that one might expect maybe explained by the group being on average taller 180.97±5.06 mm.

TABLE 1

MEANS AND STANDARD DEVIATIONS OF ALL VARIABLES

VARIABLE	TOTAL GROUP (N = 82)	AGES 20-29 (N = 38)	AGES 30-39 (N = 39)	AGES 40-49 (N = 5)
AGE (YEARS)	30.71 ± 5.53	25.84 ± 1.79	33.94 ± 2.57	43.2 ± 1.93
WEIGHT (KG)	77.43 ± 9.83	77.52 ± 10.44	77.16 ± 9.72	78.8 ± 4.01
WEIGHT (Dev)* %	3.46 ± 6.7	3.26 ± 7.17	3.51 ± 6.35	4.68 ± 5.42
HEIGHT (CMS)	180.42 ± 5.72	180.97 ± 5.06	179.84 ± 6.11	180.8 ± 6.76
SKINFOLDS (MM)	46.6 ± 11.71	44.78 ± 11.83	47.92 ± 11	50 ± 8.1
BODY FAT (%)	19.125 ± 3.65	17.23 ± 3.26	20.85 ± 4.75	24.26 ± 2.11
FAT (Dev)* (%)	30.81 ± 21.26	32.47 ± 24.98	27.75 ± 19.25	34.61 ± 11.51
SYSTOLIC BP (mmHg)	129.25 ± 10.84	129.68 ± 11.35	127.51 ± 9.99	133.8 ± 8.56
DIASTOLE BP (mm Hg)	80.67 ± 9.9	77.44 ± 10.36	83.07 ± 8.87	86.4 ± 4.75
HEALTH STATUS	12.67 ± 3.34	11.18 ± 3.11	13.79 ± 3.00	15.2 ± 2.31
ACTIVE EXERCISE	51.21%	55.26%	53.84%	40%
SMOKERS (%)	24.39%	15.78%	35.89%	NIL
MAX OXYGEN UPTAKE (ml/Min/Kg)	46.5 ± 9.05	49.64 ± 9.05	44.76 ± 8.22	36.05 ± 4.01

3.4 Discussion

The fitness profile has identified many of the fitness and health characteristics in a group of aircrew personnel. All aircrew are thoroughly screened medically before intial engagement into the Air Force, and this is reflected in the low level of risk factors in evidence which might degrade their health status, This screening examination designed to exlude those not meeting prescribed physiological and psychological standards has been operative since World War 11. Studies then by Greybiel and West (1945) on naval aviators found this factor of 'high' physical fitness a strong influence in their conclusions in that it was apparently unnecessary to maintain superior levels of physical fitness during training. There was found in this study by Greybiel and West no relation between physical fitness and flight performance, a conclusion reached by many findings and investigation since.

Most problems in health risk are thus self initiated, namely:- smoking, fat, minimal exercise and inability to modify stress. Each of these factors is influenced by some or all of the others, thus, an evaluation of an individuals 'strengths' and 'weakness' enables him to understand and therefore modify his problem, improving his 'energy' potential. The concept of 'energy' identified by Larner (1974) consists of both physiological and mental components and found to be of high validity as a pilot reliability prediction.

Aircrew identified in this study as a having lower than desirable aerobic indices, in the majority of such cases would improve purely by reducing their body mass, increasing their lean body

mass. Therefore to take only an aerobic test alone as a measure of physical fitness could be considered unsatisfactory other than a gross measure of 'fitness' permitting reasonable comparision of groups.

The deviation of weight from desirable norms is not significant 3.46 ± 6.7% but the level of fat is high 30.81 ± 21.26. This highlights both the high level of white fibre and its resultant effect on the aerobic power of the individuals and also the overall poor muscle tone due to reduced level of red muscle fibre.

In general the main problem of aircrew is the sendentary nature of their job, identified in the following chapter, resulting in a lack of muscle tone and increase in body fat. A simple series of calesthenics may greatly improve this situation and relieve much of the prevalent back and neck strain due to poor flexion and mobility in these areas. Klein et al (1977) suggested there might be little advantage from fitness in tolerance to +Gz physiologically but indications are that physical fitness would enhance mechanical efficiency of the individual and alleviate these problems. This would obviously necessitate an increase in exercise but not a punitive regime!

The dangers of a general approach to physical fitness could have an effect in two ways, the prescribed remedy could be too little for some, too much for others and in both cases not be sufficiently specific to satisfy needs. Each individual has varying strengths and weaknesses as stated earlier and each individual has developed personal strategies to accommodate them

and still portray efficiency. The continuing theme of this study will be to evaluate these individual factors of fitness, health and stress and their relationship.

A fat paunch never bred a subtle mind.

Anoymous Greek Writer

4. GRADING THE INTENSITY OF PHYSICAL WORK IN AIRCREW

4.1 Introduction

THE AIM OF THIS PART OF THE STUDY WAS TO DETERMINE THE AMOUNT OF PHYSICAL WORK INVOLVED IN FLYING A HIGH SPEED MILITARY AIRCRAFT LIKE THE PHANTOM.

Physical work can be graded simply in a descriptive way by rest, sedentary work, light work, moderate work and heavy work. However, this form of discription is only approximate and subjective, and largely useless in a scientific evaluation of work intensity in aircrew. To achieve a more quantifiable measure of work intensity, heart rate recordings were considered a suitable form for assessing the intensity of physical activity during work in aircrew. Earlier work carried out to monitor and record cardiac reponses to mental and physical stress in military personnel has shown that portable ECG recording systems can give good signals under a wide range of 'active' physiological and environmental conditions.

In addition work results from this part of the study would serve the dual purpose of broadening the background of the evaluation of the relationship of the physiological and pyschological factors in stress as discussed in Chapter 2.

The work was carried out in two situations; in the flight simulator where control of a variety of simulated work tasks and emergencies could be carried out; and secondly in the air where tabulation of timings and events were recorded using a portable tape recorder. One additional feature of the simulator evaluations was the perceived stress or workload form (see Appendix 3). The purpose of this form allowed both recording of incidents taking place in the simulator and it also permitted the individual crew member the opportunity to subjectively assess his

workload at each particular main incident. Comparison between this personal perception and the ECG recordings then took place later. This part of the experiment was not possible with 'live', sorties as a diary of events had to be taken from the voice tapes at a later date.

The normal 'sortie' time of either the simulator flights or live flights is approximately 1.1/2 hours from take-off to landing. Preparation and debrief on a simulator flight is approximately 30 mins either side of this time. On a live sortie preparation and debrief can be as much as 1 hour either side. Thus the build-up in both events can be long and labourious, as can the debrief.

This study was carried out on one of the UK's front line airfields where a 24 hour state of readiness is maintained by a number of aircrew. They are known as the quick reaction aircraft (QRA) maintaining a 'fire-brigade' posture. Reaction times can therefore be foreshortened and flying times lengthened by 3 or 4 hours by in flight refuelling. Regrettably operational constraints prevented any recorded data, on such QRA 'live' sorties. But simulated QRA training sorties which are part of the standard practice were recorded and the results are discussed accordingly. Any reference to live QRA sorties are anecdotetal and based on experience by individuals.

The aircraft concerned in this study is the Phantom jet fighter, which has a crew of two, pilot and navigator, who sit in tandem one behind the other. Neither the pilots position nor the navigators position could be determined spacious with every conceivable area around each seat taken up with instruments,

4 The "Real" working environment.

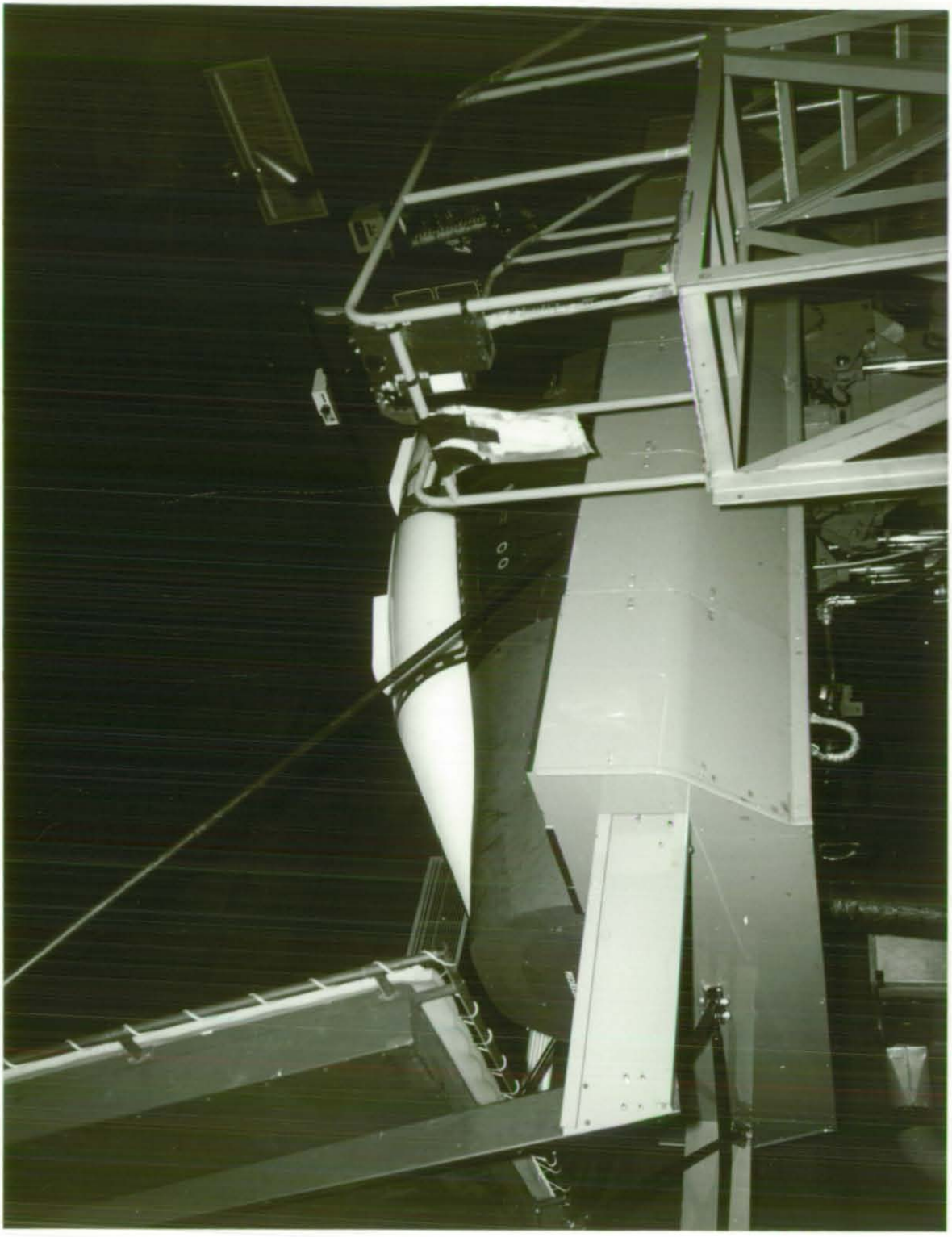
knobs and switches. To add to the navigators discomforture is the fact that 90% of his forward vision is obscured by instruments and the rear of the pilots ejection seat. These seats are functional, firm with minimal comfort, and for obvious safty reasons each crew member is restrained by chest safety harnesses and leg restraints.

To add to the constrained working environment of the aircraft cockpit both crew members wear flying clothing on three layers. The inner layer is the regulation 'bunny suit' which is a heavy knit under wear, next comes the normal flying overall and due to the many hours of over-flying water the outer layer is an immersion suit with sealed feet, wrists and neck. The flying helmet or 'bone dome' complements the outfit weighing on its own 8-9 lbs.

The physical stress from his working environment and clothing alone presents considerable problems for the physically less fit. (1)

4.2 Methods

Thirty - eight aircrew, all fixed wing, participated in this part of the study. The group consisted of 22 pilots and 16 navigators. The inbalance of pilots to navigators was caused by the fact that recordings and monitoring was volountary which meant in some situations both members of a crew would not necessarily both volounteer. In addition simulator sorties were taken by individuals on an opportunity basis to fulfil particular training tasks, which frequently resulted in crews not being regular pairs. This would prevent some crews being monitored as pairs because the pilot or navigator may have been monitored



5. The Phantom Simulator.

previously. So only where it was considered necessary for standardization of a previous recording would he be monitored again.

The mean age of the group was 29.63 $\pm$ 5.21 years.

Of the 36 aircrew measured it was possible to record only 9 of them in both situations, simulation and live. The simulator tasks and sorties all had a basic framework as identified on the form at appendix 3. During each sortie the particular task was inserted and the time elapsed marked opposite. Thus the ECG recording when analysed could be compared with the record of events for any relationship. Also on this form were a series of score tables on which each individual after a simulator sortie was requested to insert an appropriate score for his subjective assessment of his workload and perceived stress for that particular task. This was not done for the live sorties as voice tapes had to be analysed to dicover tasks and time sequences with the resultant delay.

The Oxford Medilog ambulatory ECG recording system (Oxford Medical Systems Ltd) was used for all recordings. The recorders selected were the 4-24 type with C-120 magnetic cassettes and Medicotest electrodes. The recorders, in small cases (12 x 10 x 41/2 cm) were worn by subjects around their waist, against the skin, under their flying clothing. Two standard ECG chest leads were used. A display monitor was used for initial exploration with the first few subjects to determine the optimal positions for the leads.

The ECG tape records obtained were analysed on the computer

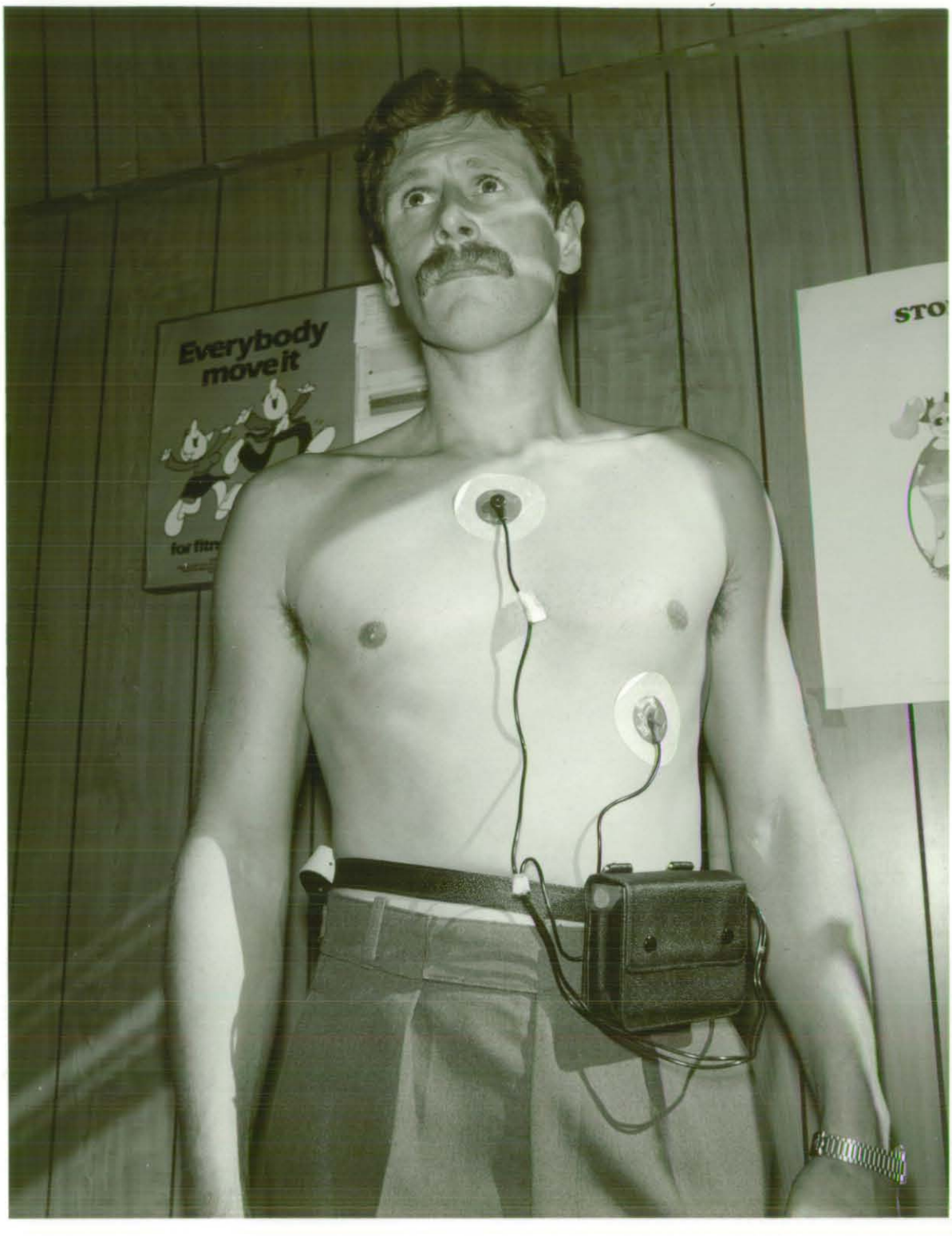
analyser in the Cardiology Department, Edingburgh Royal Infirmary. Both visual display and printouts were obtained to determine whether the records would be of good enough quality for accurate reading of heart rate changes, indentification of arrhythmias, the occurrence and frequency of ectopics and any other possible abnormalities.

In most instances recorders were affixed to the subjects before the briefing for the sortie, simulated or otherwise. Similarly where possible the recorder was allowed to run for a short while after the sortie.

The flying time of the average sortie (live and simulated) lasted between one and two hours during which the subjects were involved in a number of tasks. Within the simulator sortie the various inputs of workload tasks would involve training emergencies such as engine fires, or various system failures but for obvious reasons unless by coincidence live sorties involved the normal air defence role of seeking possible hostile aircraft, identifying, and simulating a 'kill' if necessary. The simulator trip also had the primary task of training the necessary tasks of identifying searching, and eliminating if necessary.

A total of 57 recordings of individuals in both situations were taken. This number included ten re-tests for standardization and nine live sorties. Also for comparison and interest six of the original 38 recordings were done with the pilot and navigator in reversed roles, this being a regular training activity to permit each to familiarize himself with the others role and working environment.

A cross section of the recordings and their analysis is given in



6. The Oxford Medilog (ECG Monitor).

the following results.

4.3 Results

Fifty-one of the fifty seven recordings were of good quality. The remaining six had slight abnormabities on tracing, but these were identified by the technician and an overall analysis was still possible from printouts. It was considered muscle interference as the most likely cause, the common feature being that 5 of the 6 were pilots possibly giving the excess movement with the control column.

The printouts were analysed for any ectopics or abnormal features. As would be expected in such a healthy, fit and medically screened group no abnormal features or ectopics were in evidence. The main cardiac reponses were, as expected, increases in heart rate in general and variation in rate according to basal fitness, environment (live or simulated), and changes in subjects activity and inducted tasks. There was little obvious difference between heart activity in a live or simulated situation, probably indicating normal physological arousal effects, typical in all flight situations, to facilitate increased blood flow and increased oxygen intake and uptake, with associated rises in blood pressure and circulating levels of catecholamines.

Each print out was also analysed for five other features namely the average work or arousal level (WR), the maximum peak rate, (PR) the lowest rate (LR), the take off peak (T/O) and the landing peak (L) The mean and standard deviation for the group features were established (Table 2).

TABLE 2 MEAN AND S.D FOR THE 5 HEART-RATE FEATURES

OTAL	(WR)	(PR)	(LR)	(T/O)	(L)
=38	85.26±16.11	106.32±16.4	83.26±13.25	101.05±14.26	98.84±13.78
20-29)N=22 Years	79.45± 5.72	103.09±9.51	81.09±8.83	99.27±10.1	96.36±8.98
30-39)N=16 Years	93.25±21.47	109.25±21.09	88.5±17.11	105.5±18.64	102.25±17.9
ILOTS N=22	89.45±17.72	107.64±16.85	84.18±15.29	103.27±15.33	102.18±15.31
20-29)N=12 Years	79.66±4.95	101±9.64	77.66±8.97	96.66±7.45	95±10.82
30-39)N=10 Years	101.2±20.22	115.6±19.94	92±17.48	111.2±18.31	110.8±15.47
AVS N=16	79.5±11.26	103±13.71	82±9.64	100±13.42	94.25±9.61
20-29)N=10 Years	79.2±6.52	105±8.71	85.2±6.64	102.4±11.76	98±5.66
30-39)N=6	80±16.33	98.66±18.57	76.67±16.5	96±14.96	88±11.43

Analysis of these 5 heart rate feature with-in the group, other than the interesting comparisions of age range and job it is noted that the mean (PR) was only 106.32 ± 16.4 bpm. With reference to table 3 it can be seen that in general work intensity would only be graded as moderate. Only occasionally and for brief periods of time during monitoring on live sorties was heart-rate seen to move into what is defined as heavy work intensity.

Table 3 Grading of work intensity based on energy expenditure & heart-rate (indicative values in adult males)

ENERGY EXPENDITURE

Work Intensity	Mets	VO_2 (Litres/Min)	$\%(VO_2)$ Max	Fh (Beats/min)
Light	3	1.0	25	100
Moderate	3-4.5	1.0-1.4	26-30	100-124
Heavy	4.6-7	1.5-2.0	51-75	124-150
VeryHeavy	7	2.0	75	150

Compiled from various sources (WHO)

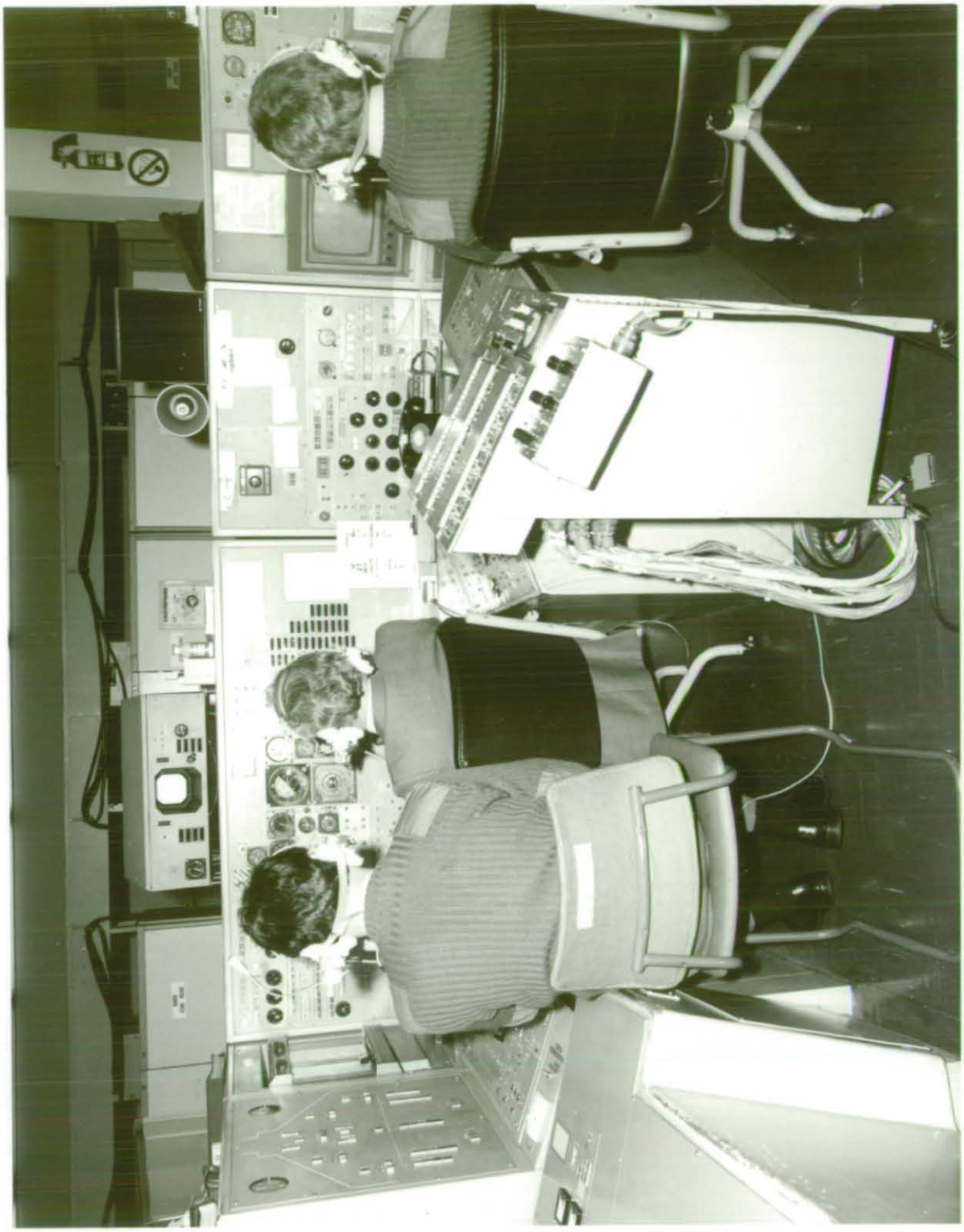
Refering to table 2 it can be noted that as heart rate is an indicant of work rate that in virtually all situations the upper age range (30-30) has a mean higher rate. The exception to this rule is when the job situation is analysed in age ranges the navigators in age range (30-39) show a reduction in heart rate

in all situations compared to navigators (20-29). This may be the influence of experience but another possibility is that 2 of the group (30-39) had recently completed ground tours in the simulator - making possibly this experience an influence on the results.

When the two features of take-off and landing are analysed and compared between job situations it was seen that in the younger group (20-29) navigators had higher levels than the pilots. But the more experienced navigators had lower levels, a possible indication of experience and adaption.

The arousal level (WR) was higher in the upper age range (30-39) even when comparisions are made with in job designiations. Despite this there was no significant difference in the range between (WR) and peak rate (PR). Equally there was no significant difference between peak rate (PR) and the lowest rate (LR) between the two age groups.

Comparisions between live and simulated sorties did show a significant difference in the peak rate (PR) but the other four features showed little difference. The few 'live' sorties recorded prevents any definite conclusions on this aspect to be reached as varying factors would affect each individual on each live sortie. Operational constraints prevented any positive standardization of this part of the study.

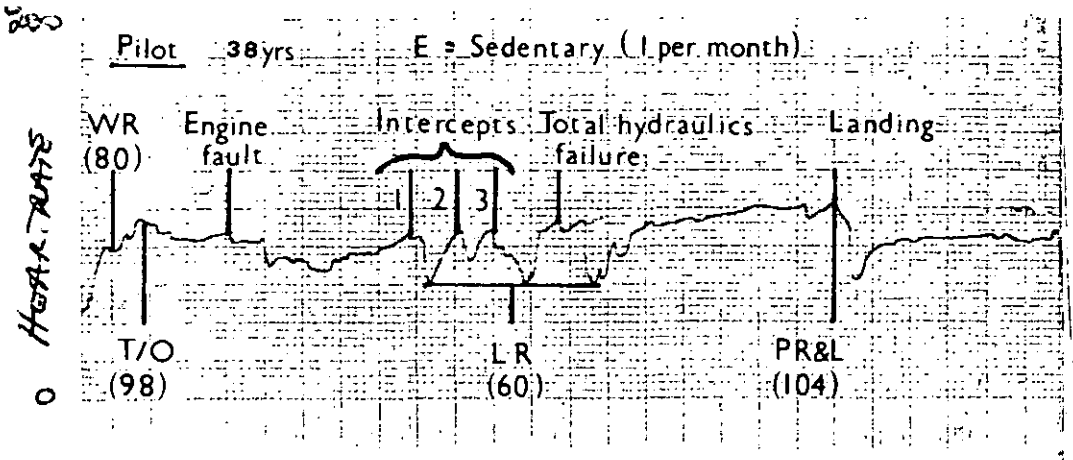


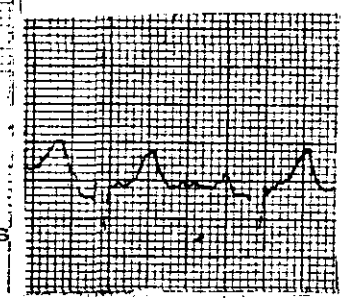
7. The Simulator control console.

WR = Work rate or arousal PR = Peak rate LR = Lowest T/O = Take-off

L = Landing ( ) = BPM E = Exercise Category

FIG 9:1

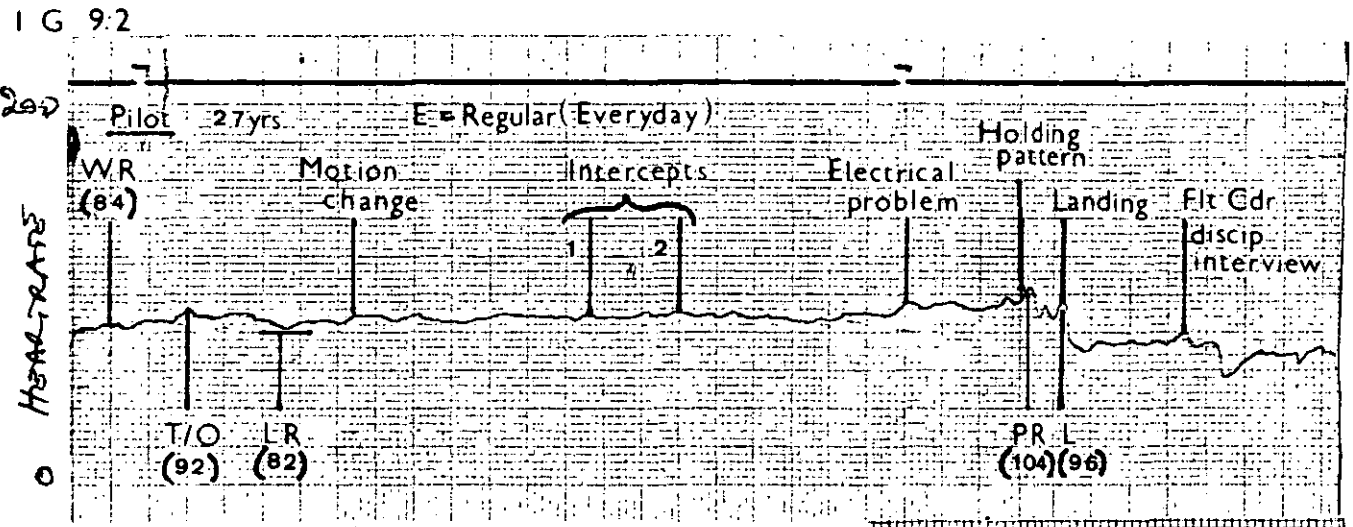


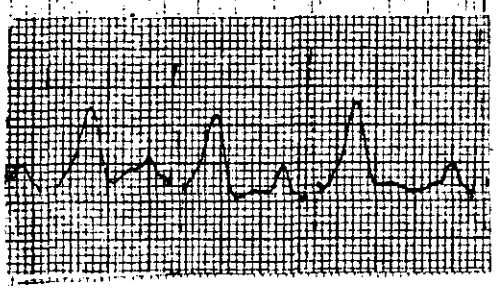


To analyse each heart-rate recording and to assign a value for work-rate (WR) a general approximation to the average rate was taken. In addition the lowest rate (LR) was taken during the period of the actual sortie was complete when lower values could be identified.

The pilot in Fig 9.1 prior to this sortie in the simulator had just completed 2 live sorties so he was already complaining of fatigue. His trace throughout exhibits constant work adaption and re-adaption. Note also the sizeable difference between the work-rate and the lowest rate a feature that as other traces will show correlated highly with the factors of fatigue, poorer physical fitness, and inexperience either singly or collectively. This pilot was experienced but fatigue was making his work performance inefficient although outwardly his performance was judged competent. Pilot (9.2) on the otherhand wa

FIG 9:2

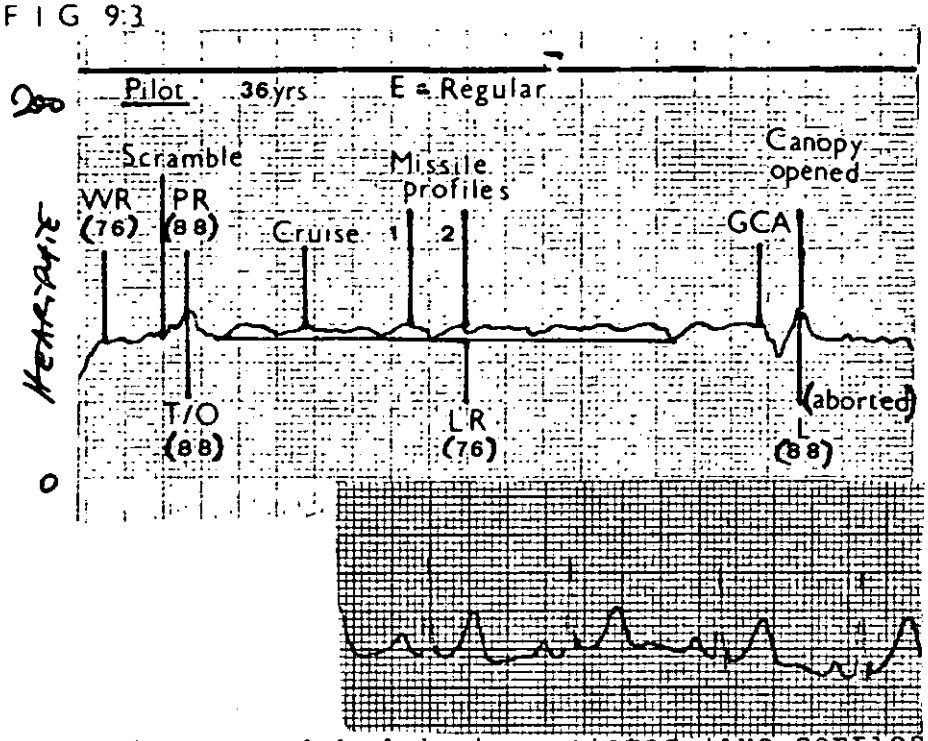




also experienced but also physically fit and his trace shows very little difference between WR and LR indicating a more efficient work performance with less stress.

Individual perception of stress endorsed thi as Pilot (9.1) considered he was never less than 4 (mod) throughout and as high as 6 during the hydraulics failure Pilot (9.2) considered he was no more than 5 even duing the holding pattern.

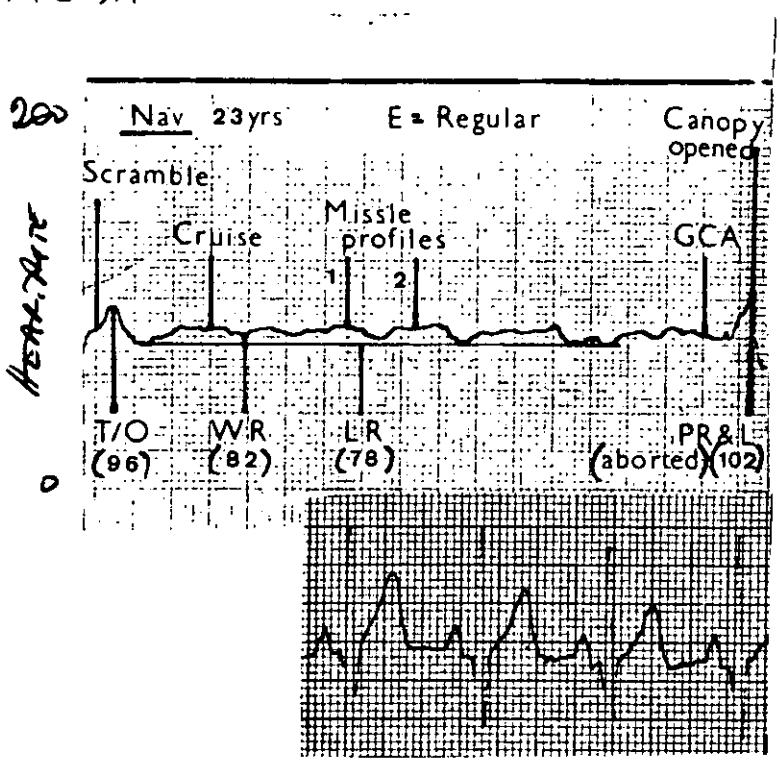
FIG 9:3



Pilot (9.3) like 9.1 had just completed five sorties prior to this simulator sortie but the feature of his trace is the similarity between his WR and LR. He is both experienced and physically fit but despite local fatigue the even trace would suggest a more efficient work performance. Even during take-off which included a system failure he felt the stress to be less than 5 (mod). When the canopy blew open unexpectedly he stated he felt stressed but the sudden rise in heart-rate is understandable in this siutation.

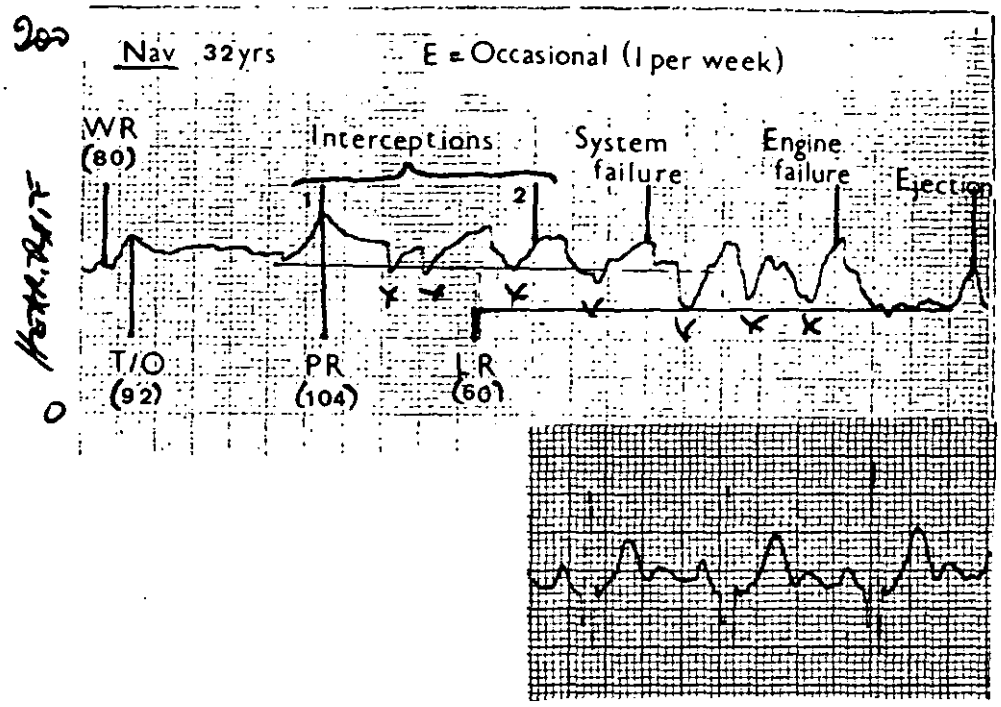
His navigator (9.4) with the inexperience of his years still demonstrates reasonably even trace. Possibly his physical fitness being an important factor in counteracting his inexperience. He stated that he considered the take-off to be stressful at 6 (High). This situation of high stress perceived by navigators

FIG 9:4



particularly young navigators was common in the inexperienced.

FIG 9:5



The sortie involving navigator (9.5) and pilot (9.6) was done with each situated in reverse roles. This situation probably accounts for the effects of muscle action on the trace of the navigator due to the many and nervous movements of the control column. He considered himself to be working at a level of not less than 5 (Mod) throughout. As could be expected in an unfamiliar role there are frequent adaptions and re-adaptions which ultimately resulted in simulated ejection.

Similarly the pilot (9.6) in the reversed role also indicated an efficient work performance and at the conclusion stated he was mentally taxed. He considered his stress level throughout to be 5 (Mod) often 6 (High). The difference between WR and LR is also significantly higher.

FIG 9:6

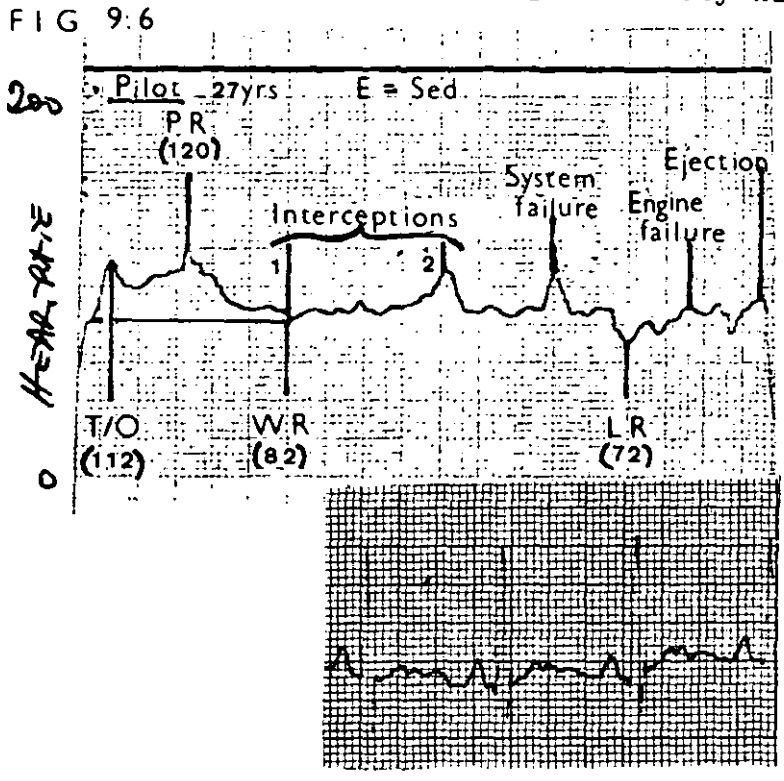
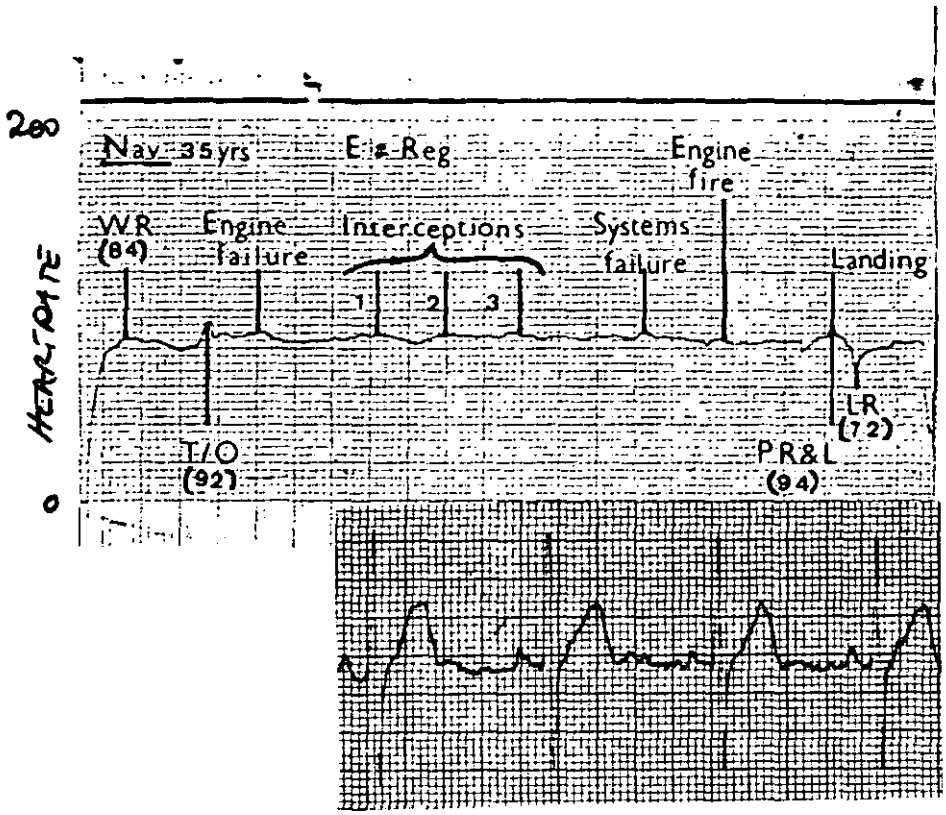
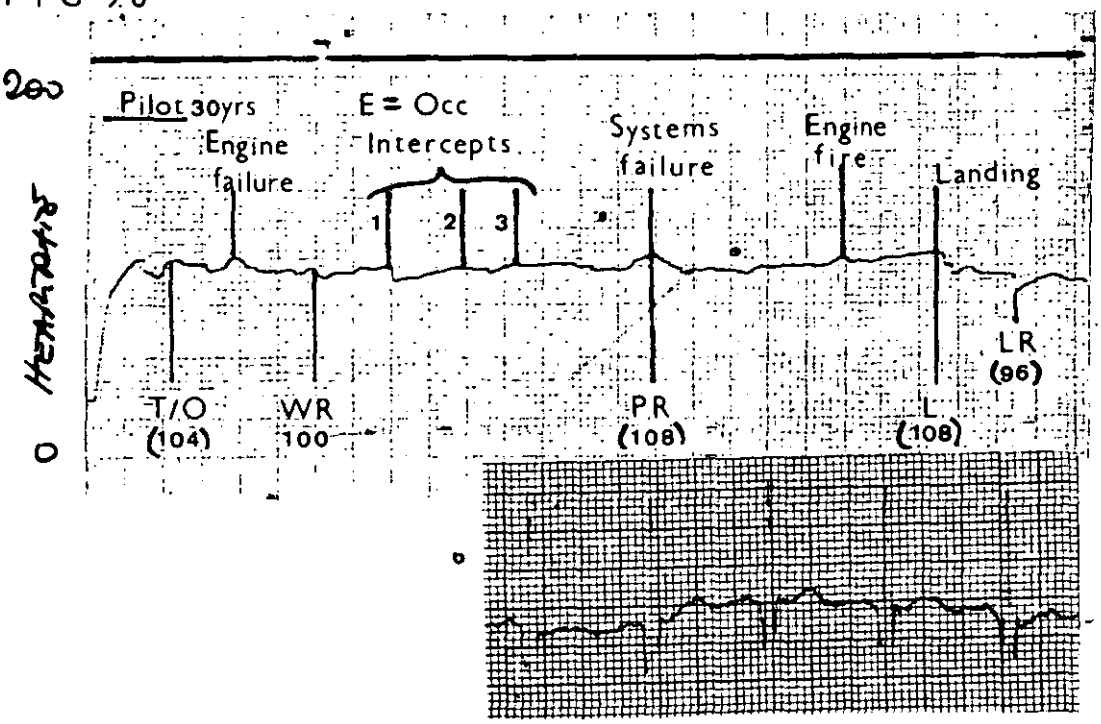


FIG 9.7



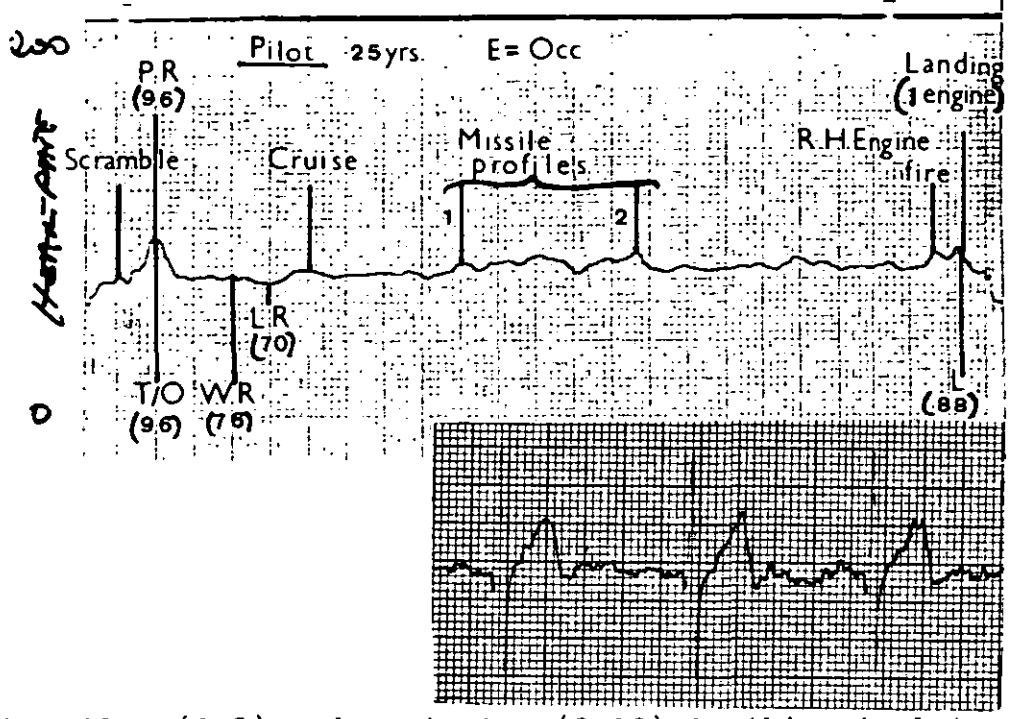
The navigator (9.7) flying with pilot (9.8) is graded physically fit and experienced demonstrates the advantage of simulator experience. Despite having been assigned to a ground tour. For the past 18 months with no flying, during a one week re-familiarisation involving this sortie he shows an efficient work trace. It is suggested that his previous practical experience is completed by a previous ground tour as a simulator instructor. His perceived stress level was a maximum of only 5 (Mod) at the 2nd intercept and also the

FIG 9.8



engine fire. His pilot (9.8) with a reduced active life-style indicated a level of 6 (High) during the engine failure although being experienced with many Phantom flying hours. His high arousal level maybe indicative of a poorer physical condition in addition to individual personality type.

FIG 9:9



Both the pilot (9.9) and navigator (9.10) in this simulator sortie are relatively inexperienced on this aircraft type. The pilot considered his level of stress in general to be 5 (Mod) rising up to 6 (High) at the engine fire. Displaying the individuality of perceived stress the navigator (9.10) stated that he felt the 1st missile profile to be 7 (High) with the engine fire as only 5 (Mod). There is a noted drop in work rate by the navigator at the 2nd missile profile suggesting a learning curve and influence.

FIG 9:10

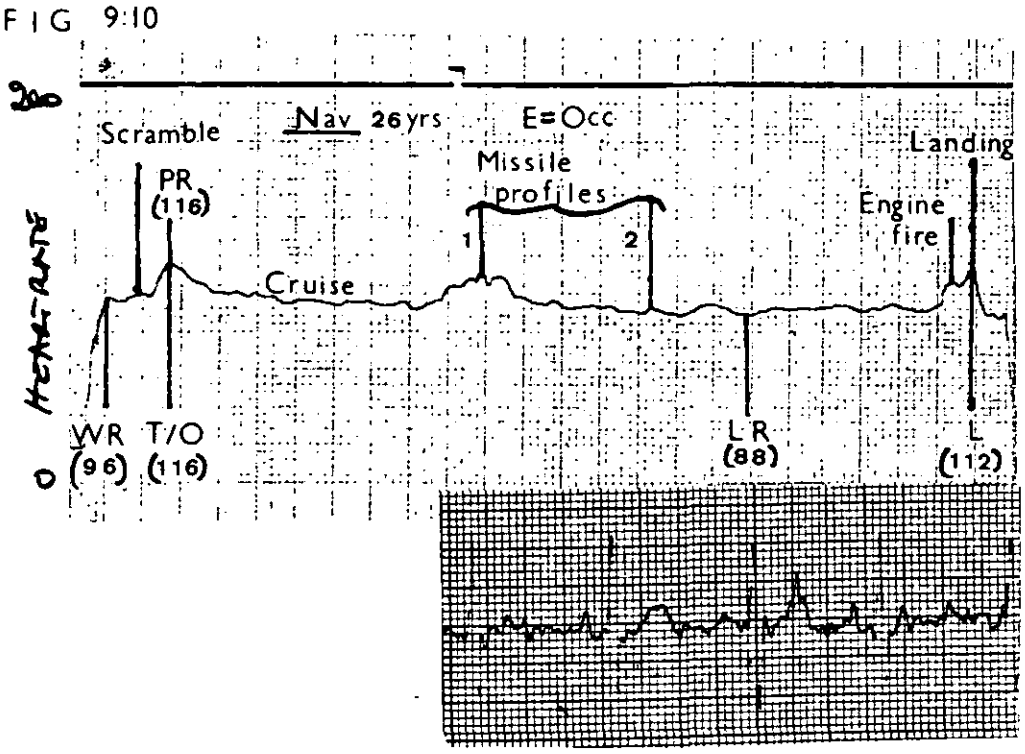
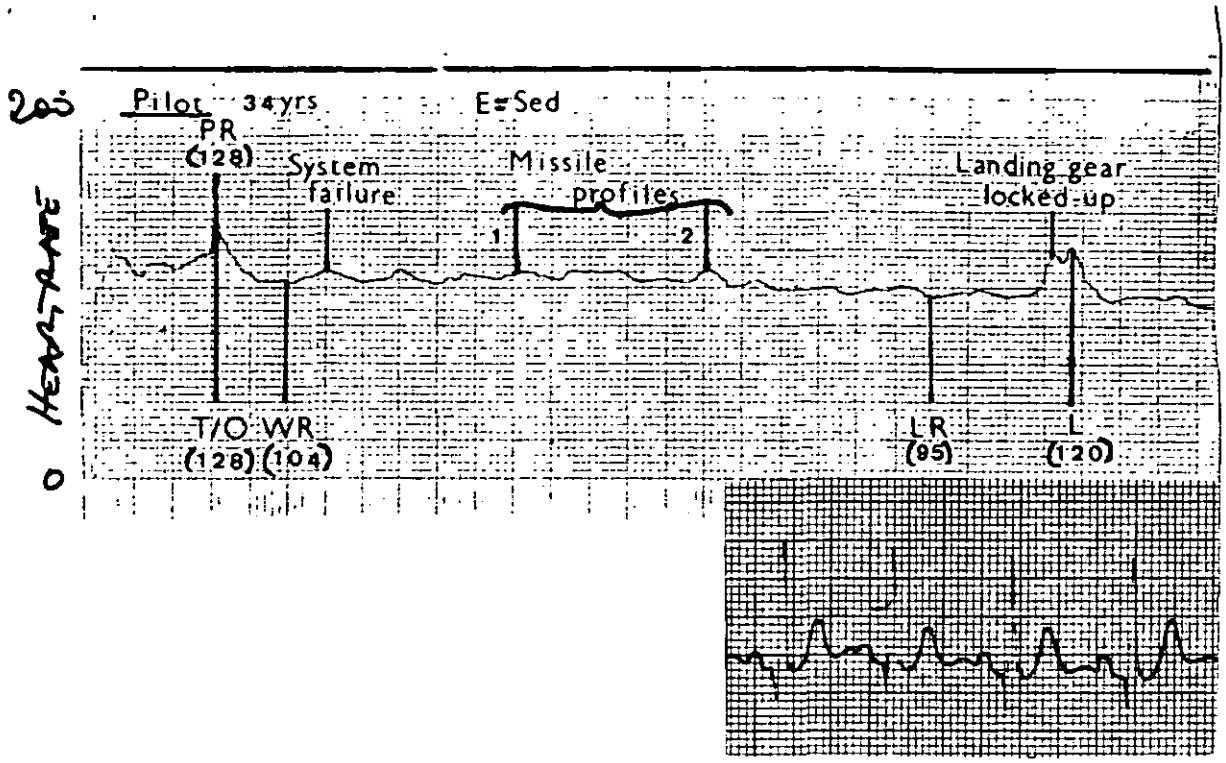


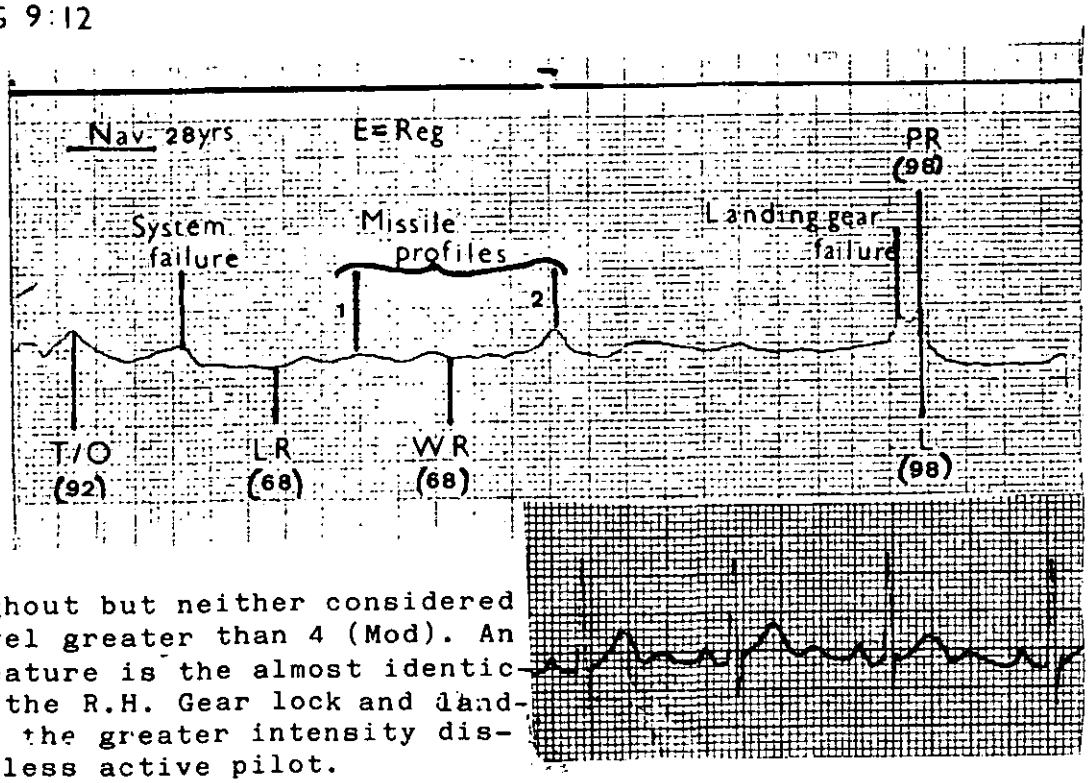
FIG 9:11



Pilot (9.11) exhibits similar features to pilot (9.8) with a high arousal level but no significant difference between the WR and LR. But the physical fitness level in both individuals, indicated by an activity level of sedentary and occasional respectively may suggest a possible relationship. But outwardly they both display competent performances in their jobs. A more active lifestyle may reduce their arousal levels but both have identifiably similar personality traits of heightened aggression and dominace in their personality analysis.

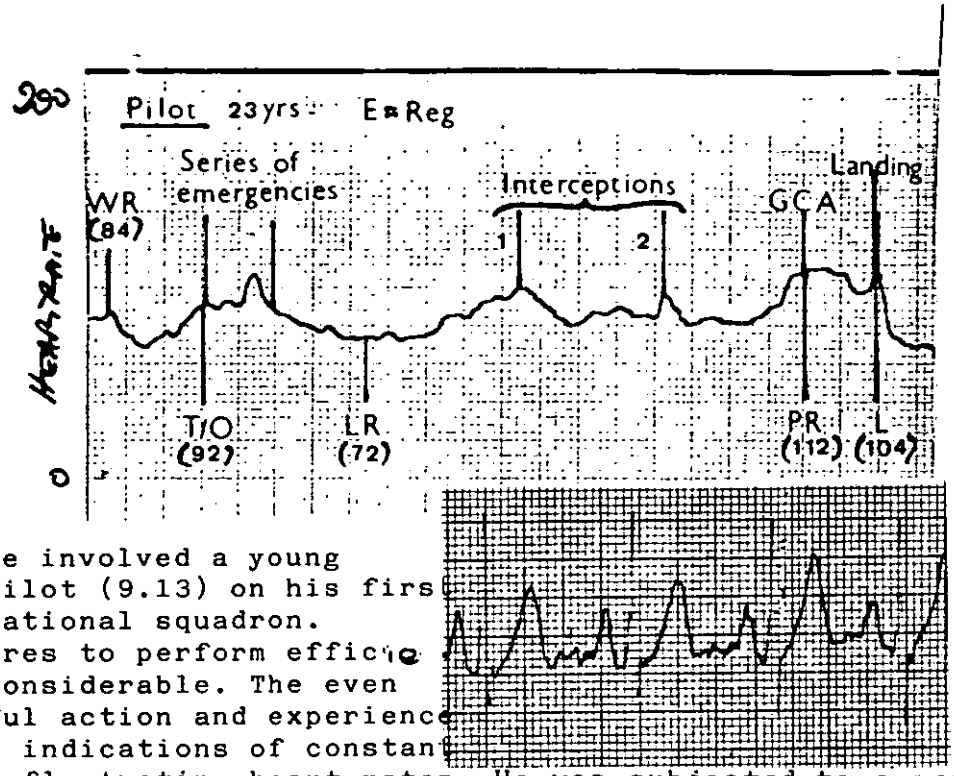
The navigator (9.12) crewing with 9.11 does exhibit a more even level

FIG 9:12



of work throughout but neither considered their work level greater than 4 (Mod). An interesting feature is the almost identical pattern at the R.H. Gear lock and landing phase with the greater intensity displayed by the less active pilot.

FIG 9:13



This sortie involved a young inexperienced pilot (9.13) on his first week on an operational squadron. Personal pressures to perform efficiently would be considerable. The even trace of skillful action and experience are replaced by indications of constant adjustment with fluctuating heart-rates. He was subjected to a more than normal series of emergencies in addition to demanding flying exactitudes with instruments alone. His perceived stress was never less than 4 (Mod) but mainly 6 (High). His navigator (9.14) was also inexperienced but the emphasis was on pilot workload so he considered his stress level to be little more than 3 (Mod). This seems contrary to the frequent waves on the trace and significant difference between WR and LR. But this may underline the psychological component of stress being the major factor as opposed to the physiological factor.

FIG 9:14

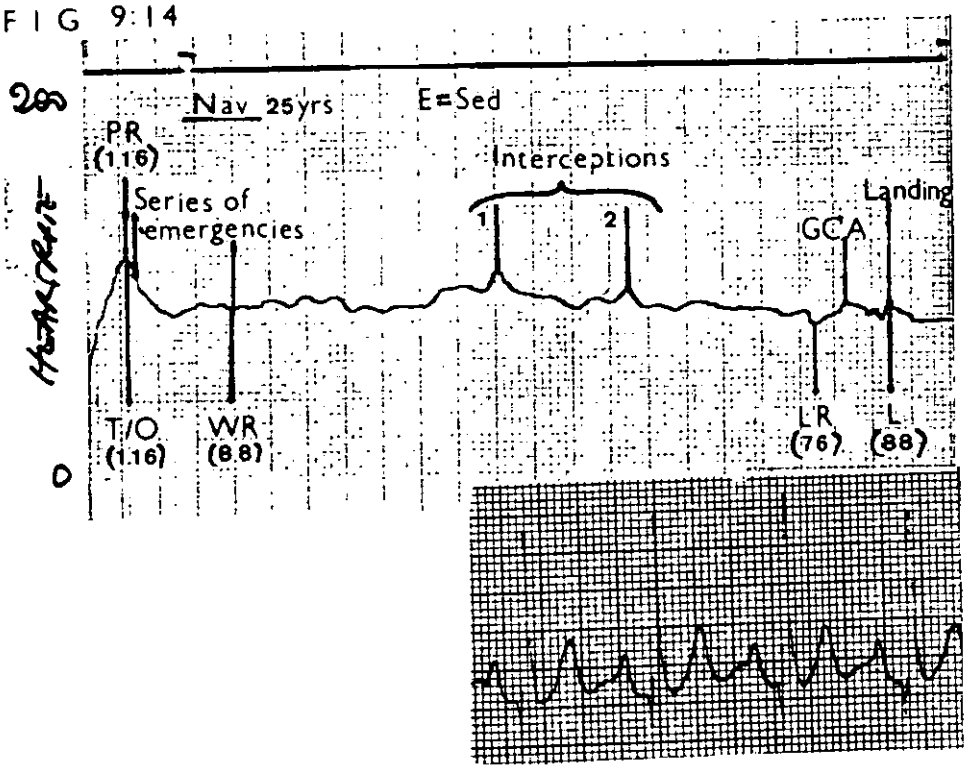
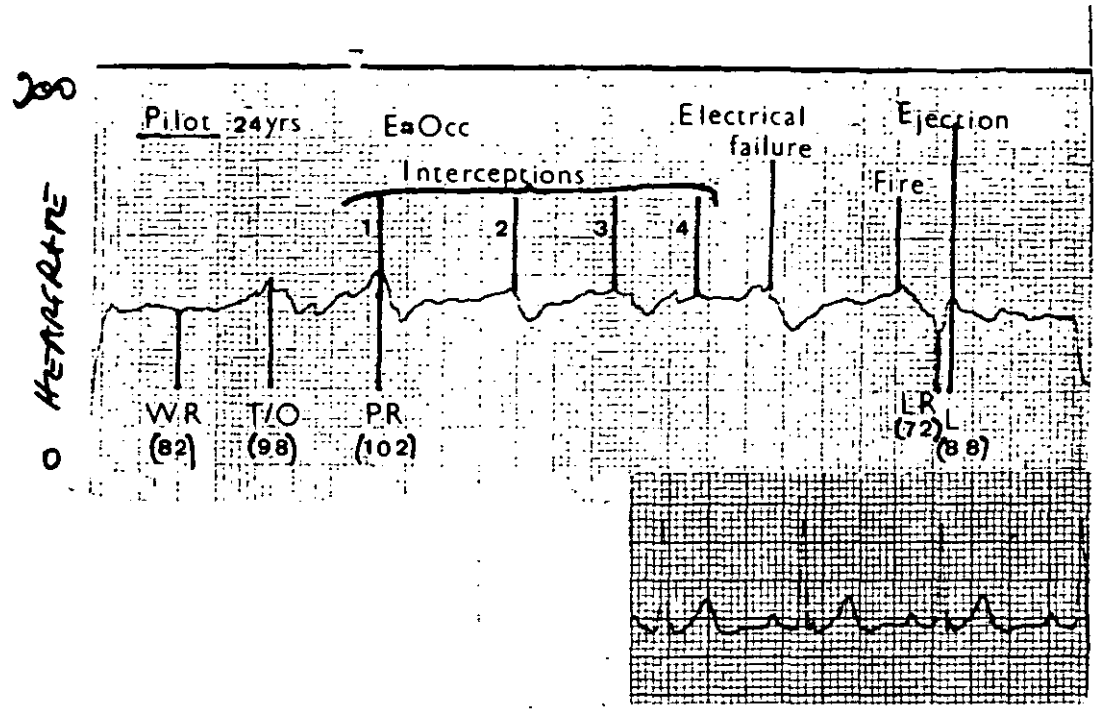


FIG 9:15



This sortie with Pilot (9.15) and navigator (9.16) again indicates inexperience as a common factor in individuals showing traces indicating inefficient work performance. But in addition as activity level reduces there also appears to be an indication of an increase in the difference between WR and LR. Also noticiable in this sortie is again the increased heart-rate in the inexperienced pilot. This feature was seen to modify in navigators with experience with no apparent answer other experience. Also noticed in this sortie is their varience of perceived stress indicated by the trace at the fire and eventual ejection phase. The pilot reacts quicker to its discovery and as captain of the aircraft has the decision to eject if necessary. The navigator who is excluded from the internal decision-making factors of the pilot once reacting to the emergency remains at a stressed level until the pilot decides to eject.

FIG 9:16

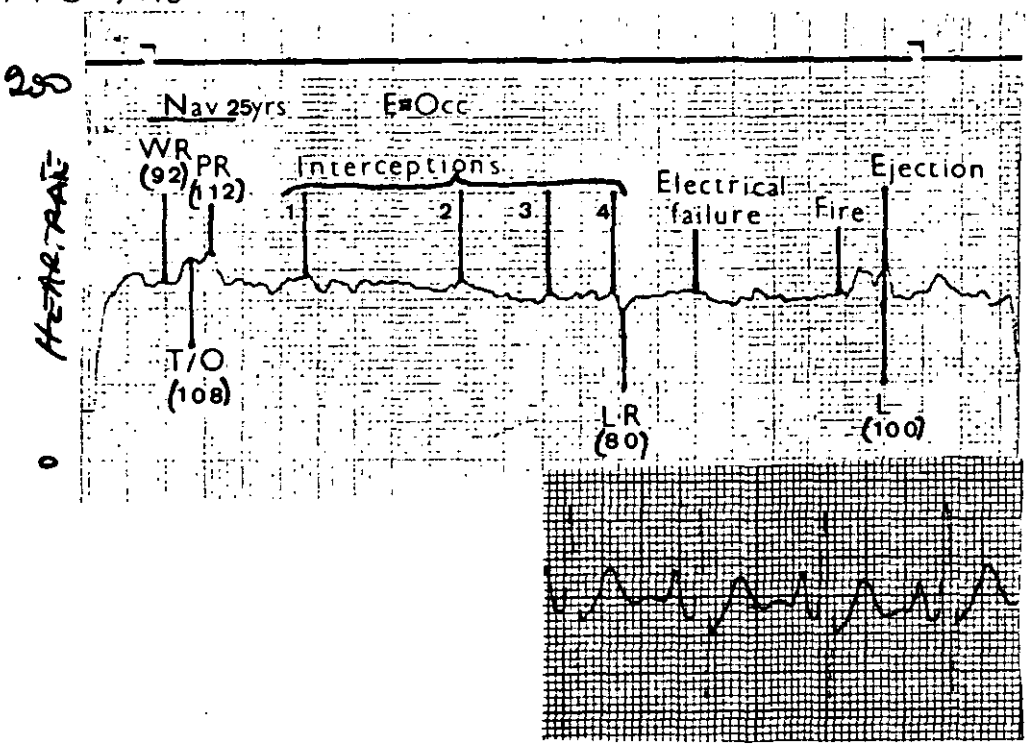
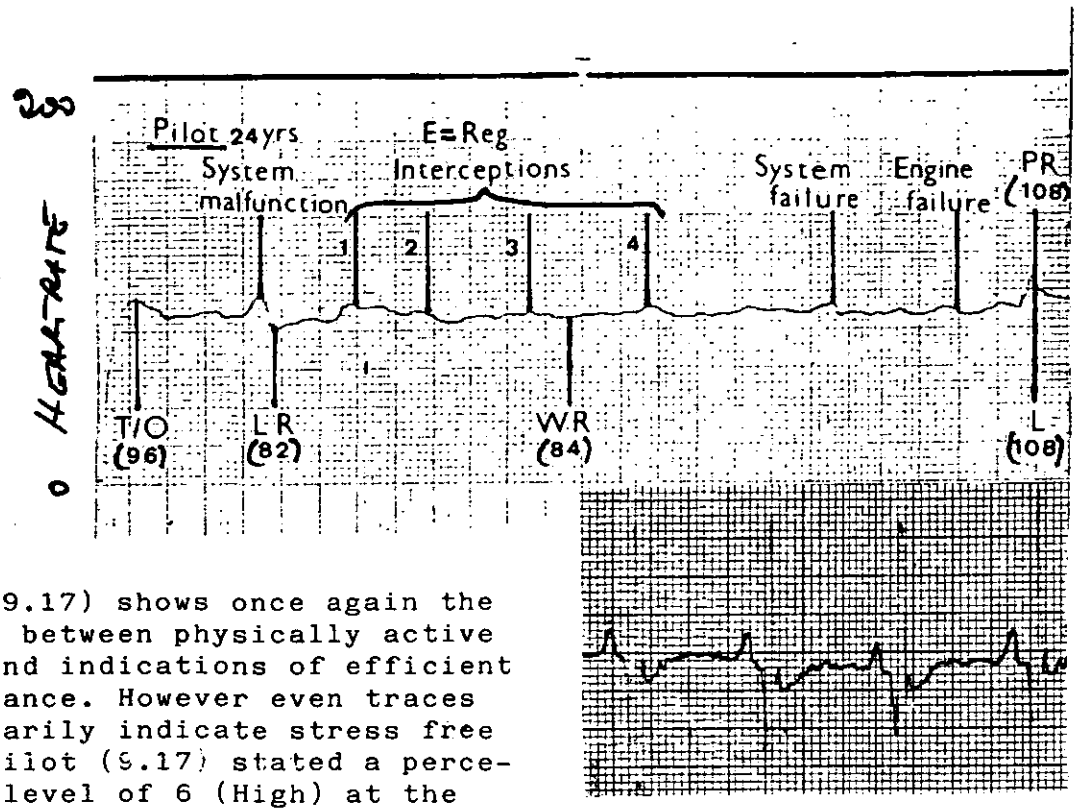


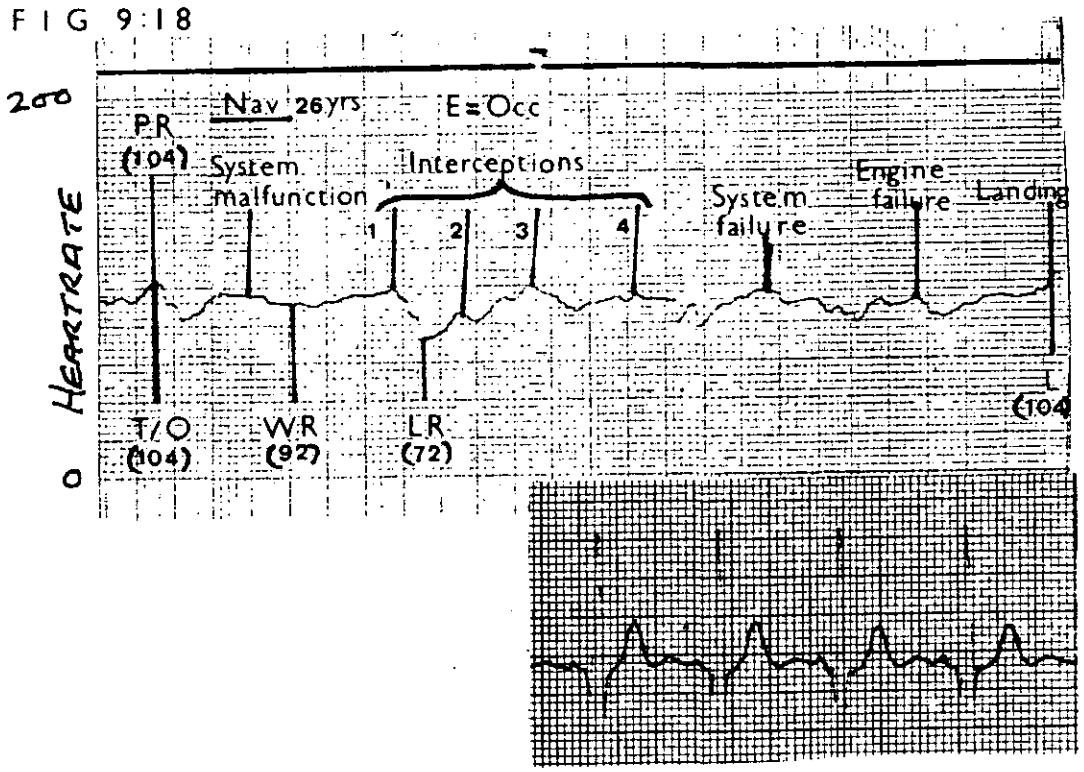
FIG 9:17



Pilot (9.17) shows once again the relationship between physically active lifestyles and indications of efficient work performance. However even traces don't necessarily indicate stress free workloads. Pilot (9.17) stated a perceived stress level of 6 (High) at the systems failure.

In discussion the navigator (9.18) spoke of a stress level of 6 (High) throughout the sortie particularly during interceptions. The recording reflects his constant adjustment and the significant difference between WR and LR. What is important to mention is that the navigator was still recovering from a wrist injury with badly damaged tendons. An important requirement for the navigator is highly skilled manipulative movements with the radar control joystick during interceptions. This explains the high workload pressure but it also demonstrates the constraints on performance

FIG 9:18



when motor function is impaired.

FIG 9:19

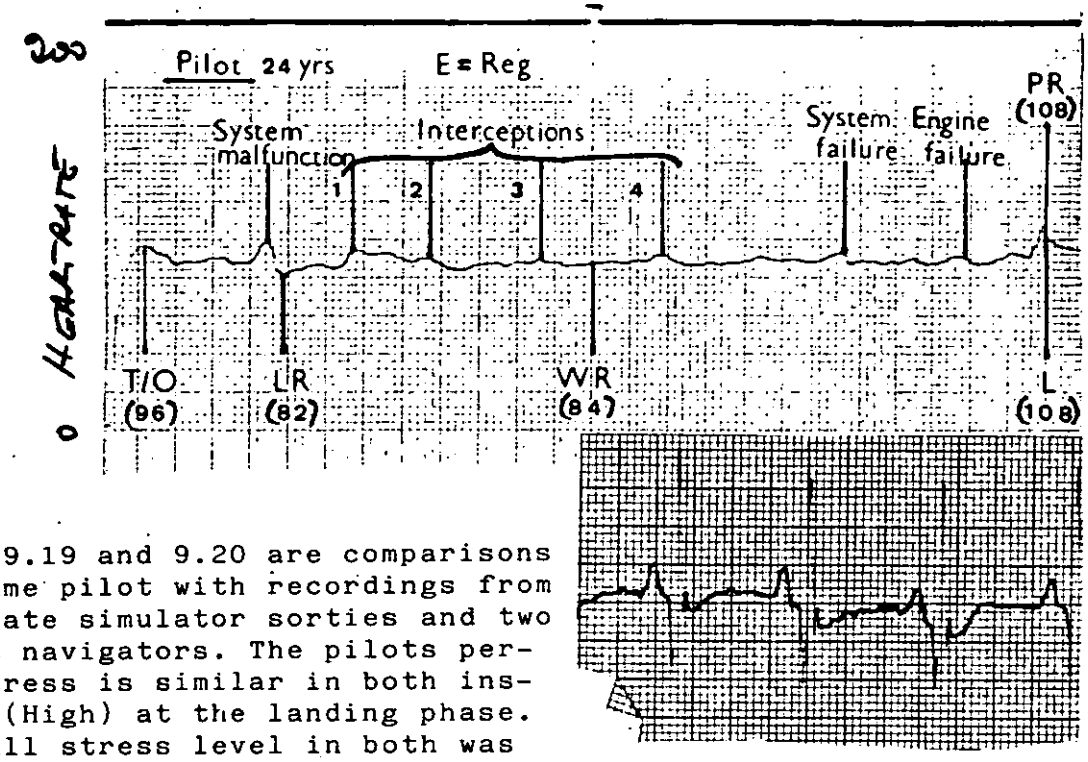


Fig 9.19 and 9.20 are comparisons of the same pilot with recordings from two separate simulator sorties and two different navigators. The pilots perceived stress is similar in both instances 6 (High) at the landing phase. The overall stress level in both was 4 (Mod). There is no significant difference between either the WR and LR readings individually or in one sortie comapred to the other.

FIG 9:20

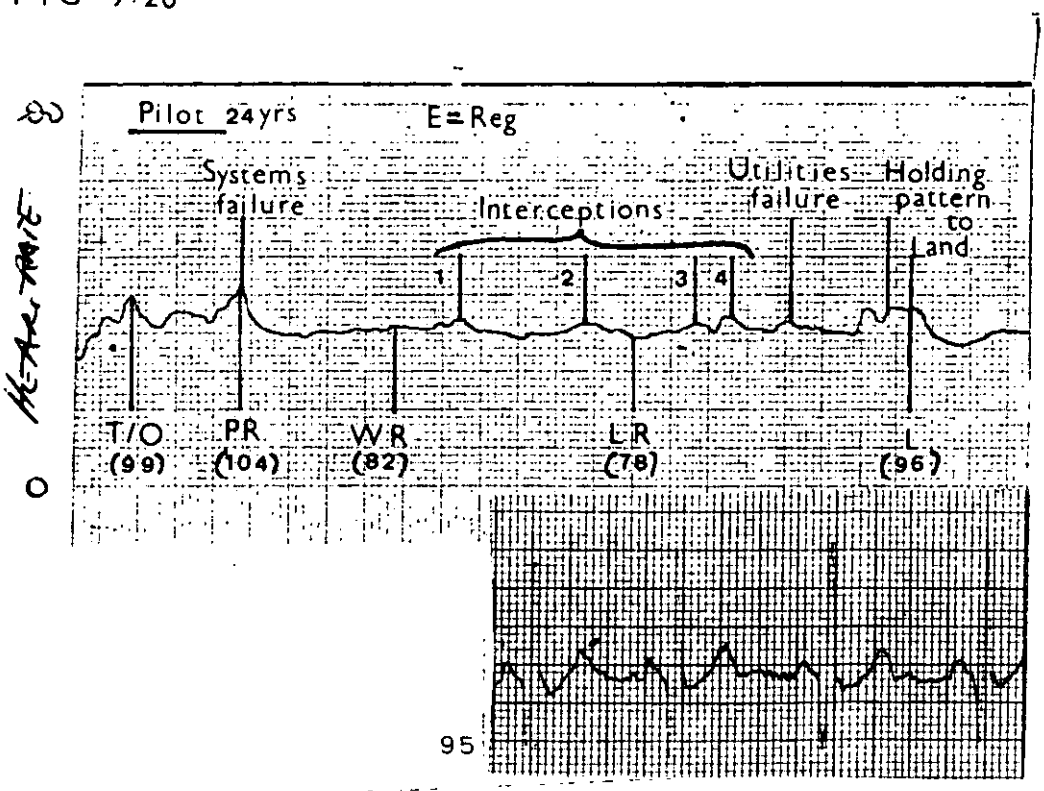
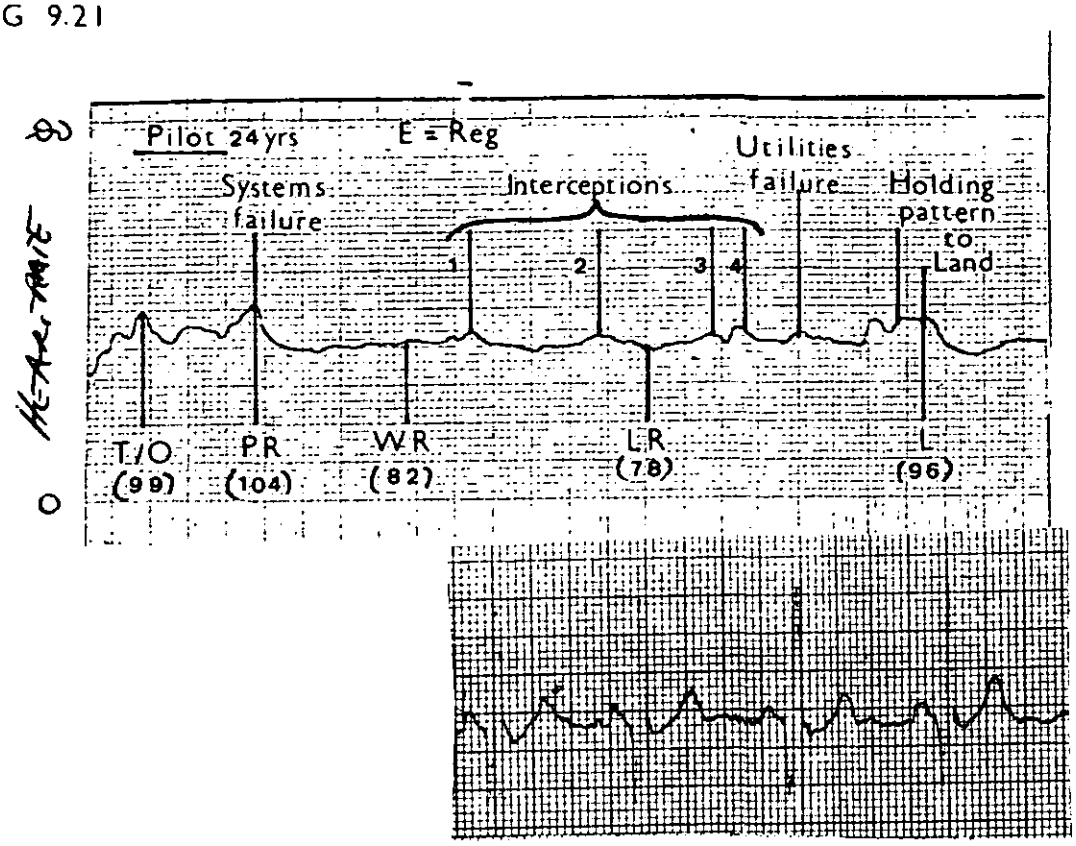


FIG 9.21



In looking at the navigator (9.22) with the pilot (9.21) there are no significant features different from those previously described on a physically active experienced individual. The only anomally is the LR of 60 near the beginning of the recording of the navigator but the even level of the remainder of the trace indicates that it is an exception.

FIG 9.22

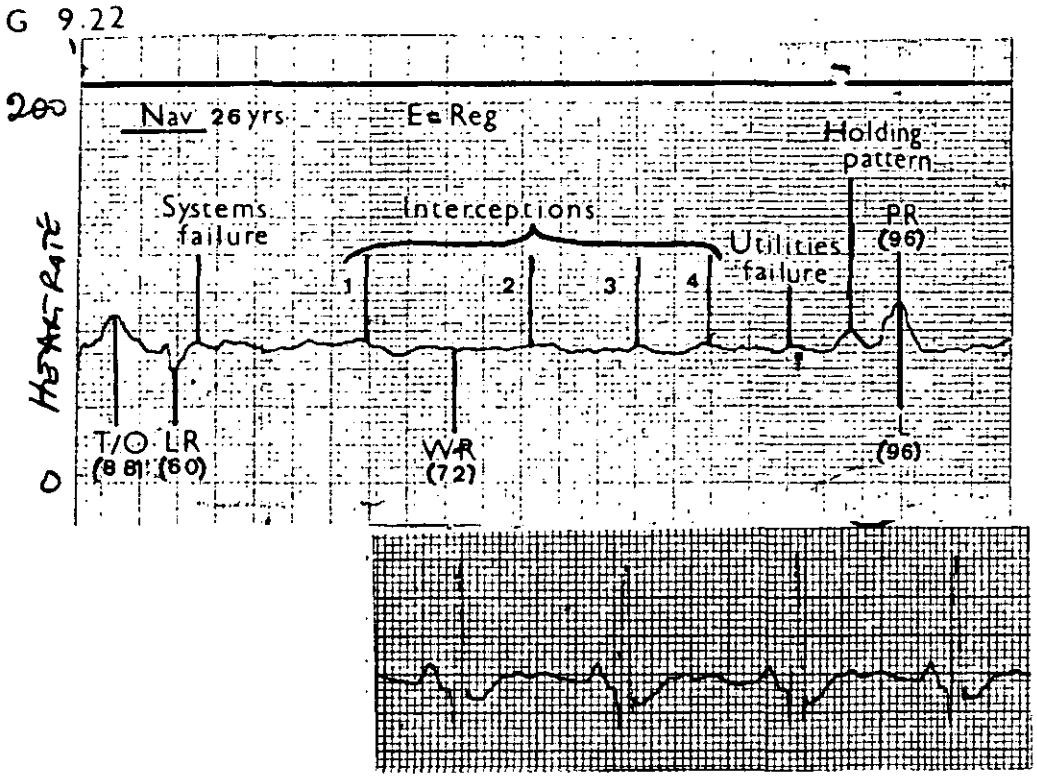
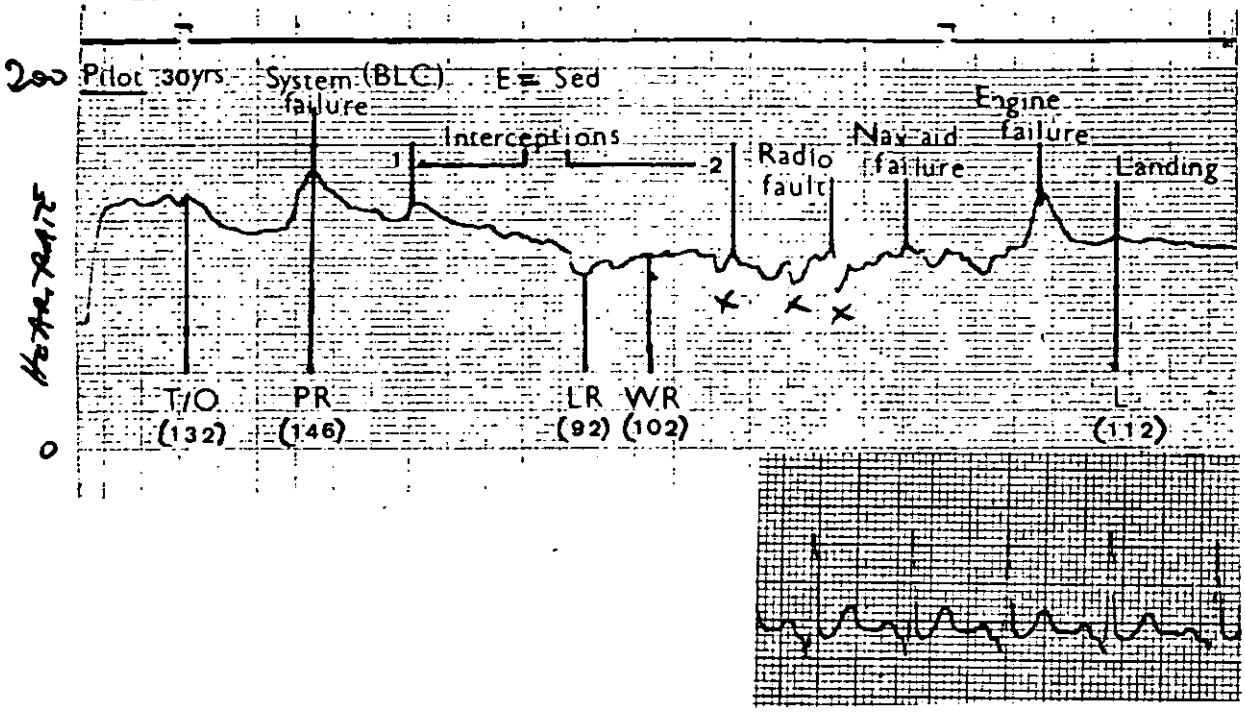


FIG 9:23



This pilot (9.23) again dispalys a high arousal level which maybe both influenced by hi lack of physical lifestyle and also a personality trait. It is noted after a period of adaption the rate comes down to a more reasonable level although still high. Outwardly he is judged to be both competent and efficient by his contemporaries. He stated his level of perceived stress at the engine failure to be high at 7 but only as 5 (Mod) at the earlierpart of the sortie despite the high rate of 146 bpm.

This navigator (9.24) shows a relatively even trace throughout and a self-judged level of never greater than 3(Mod). His simulator sortie is used in comparison to his live sortie (9.25) to identify any significant differences.

FIG 9:24

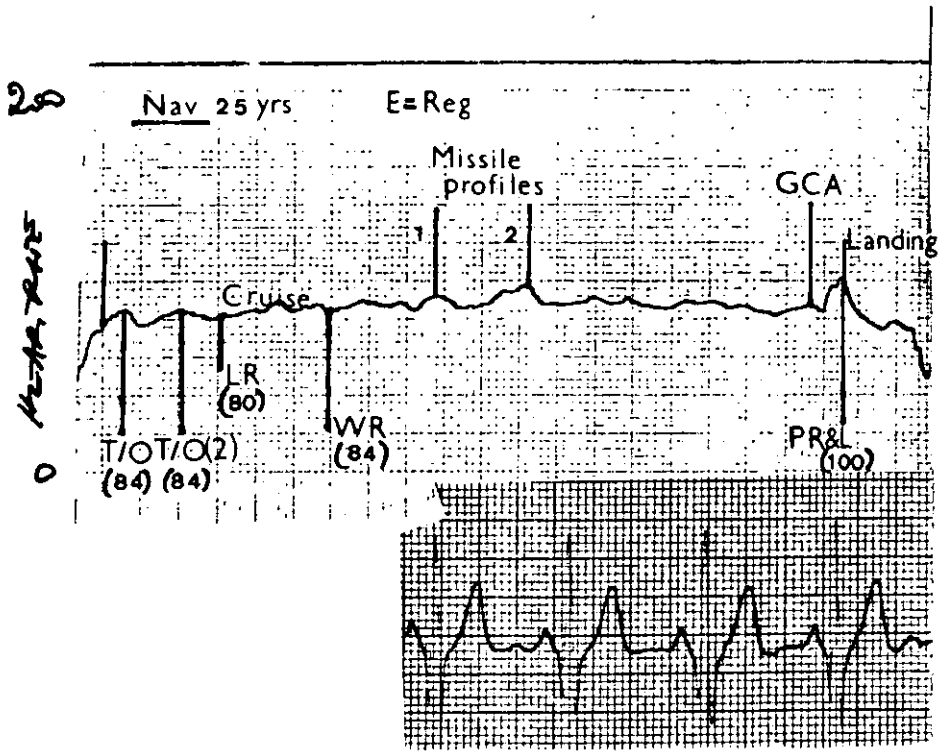
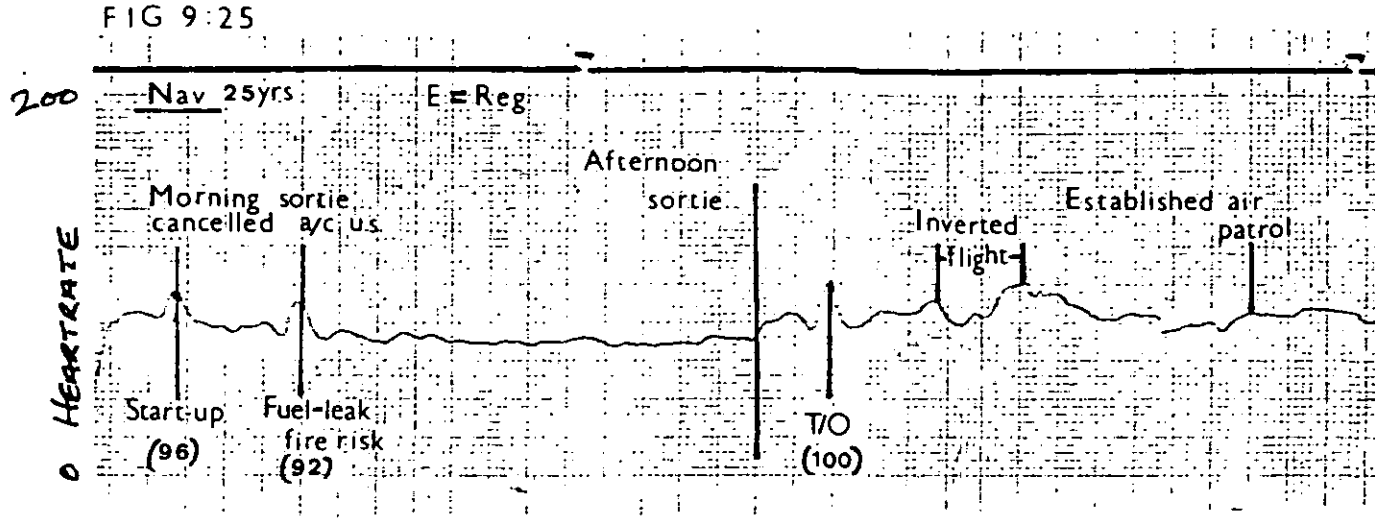
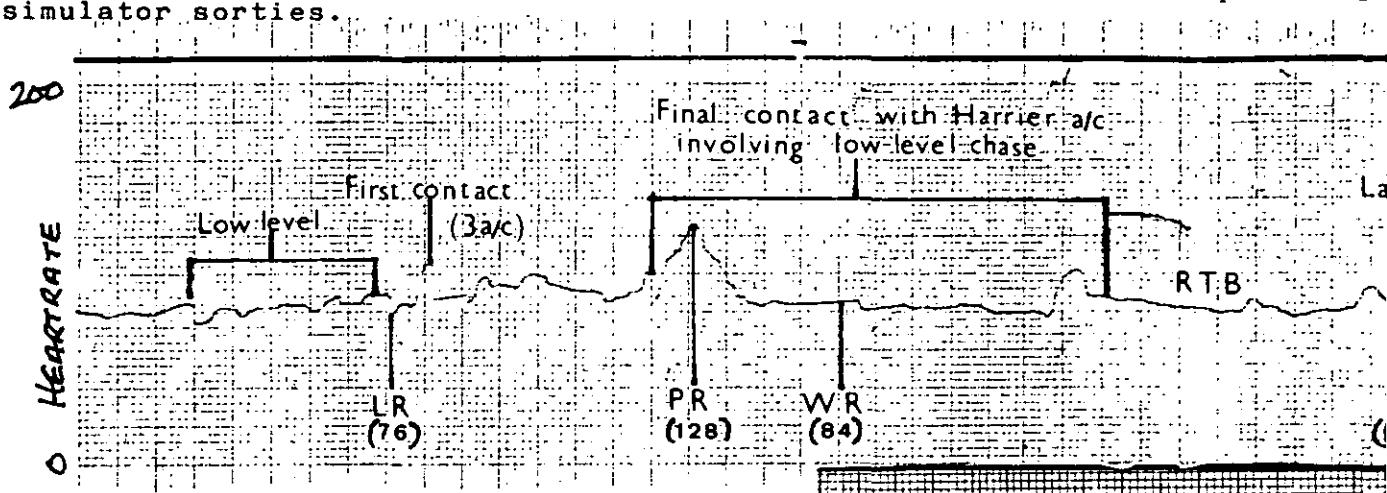


FIG 9:25



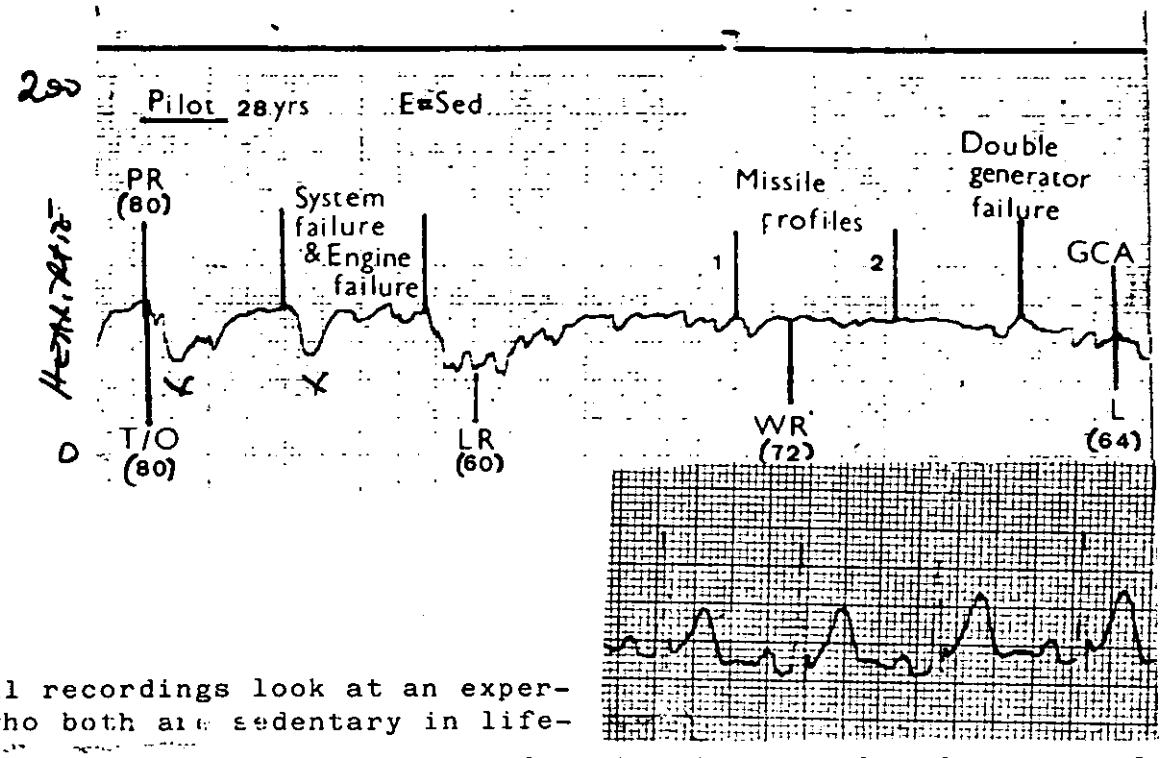
The initial sortie by navigator (9.25) was aborted after a fuel leak gave rise to a possible fire in the aircraft while still on the ground. The perceived stress at this point was only considered to be 5 (Mod).

Once the sortie was underway in the afternoon the most significant feature is the general increase in heart-rate in all situations compared to to simulator sorties.



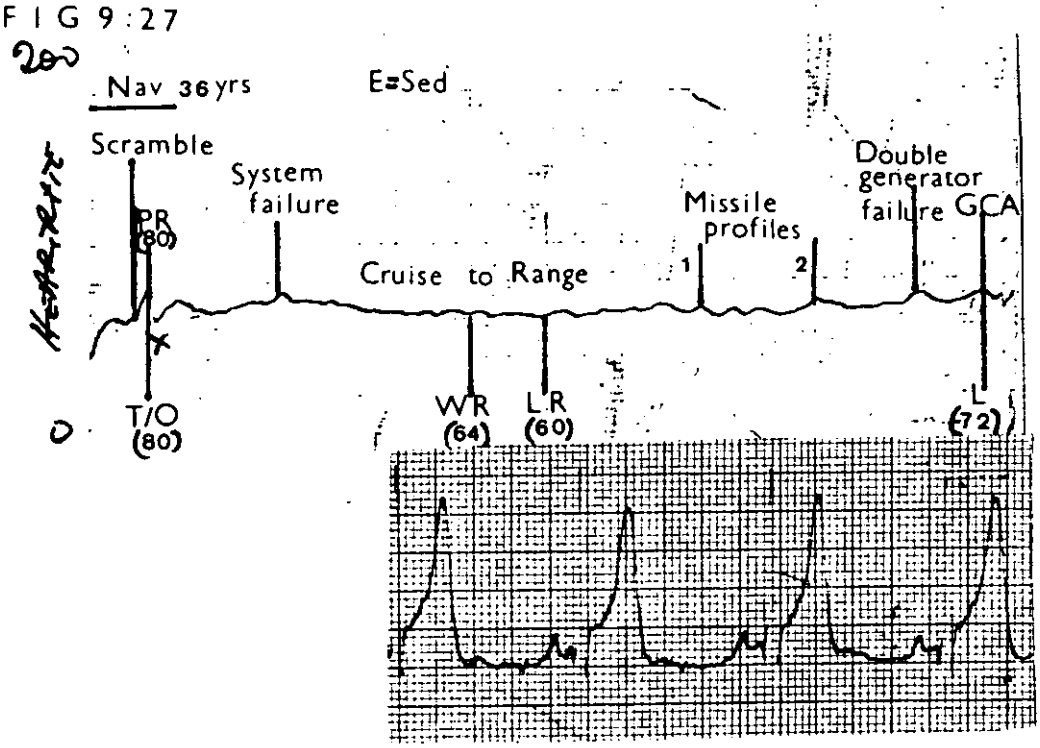
But these increases are on average no greater than 10-15%. The perception of stress was highest during the low level chase but even this was only considered as 5 (Mod). Even the difference between WR and LR was not significantly higher. These similarities were common in all of the live sorties recorded regardless whether the individuals were physically active or less so, individually the changes were proportionally similar.

FIG 9:26



The final recordings look at an experienced crew who both are sedentary in lifestyle. The navigator has the advantage of having just completed a tour of duty in the Phantom simulator. What is obvious on the pilots recording is the constant adaption throughout. At the debrief he indicated his stress level to be 6 (High) at the two main featured emergencies. This again identifies a possible relationship between exercise category and efficient work performance. However as previously in (9.7) the navigator displays how experience has a strong influence on performance and the highest perceived stress by the navigator is only 5 (Mod) during the system failure. This again highlights the variance of perceived stress within the same situation.

FIG 9:27



4.5 DISCUSSION

Not being able to standardize the recordings of the 'live' sorties is a weakness of this part of the study making the depth of study concentrate on work on the simulator sorties. As mentioned in the introduction to this chapter comparisons of the five features between 'live' and 'simulated' sortie on the 9 recordings revealed little significant difference between them except the peak rate (PR) which on average was 10% higher than simulator peak heart rates. The degree of difference was influenced strongly by the tasks involved. Reference to Fig 9.24 and 9.25 identify this difference but note the average arousal rate is lower in the live sortie.

Comparisions between age ranges (20-29) and (30-39) does indicate a higher arousal rate for the latter group. Literature identifies this as the normal physiological reponse in age to accommodate the natural % reduction in oxygen uptake. Thus to work harder it would be necessary to increase the heart rate to maintain the necessary level of work. The poorer physical condition in the older group is shown to work to his detriment in Fig 9.1. Here the subject shows a series of peaks and troughs which over a prolonged period of time degrade his efficiency. The better conditioned younger pilot Fig 9.2 shows similar work rate but maintains this level, rising only when induced by a particular task. This results in a more efficient expenditure of physical energy.

Similary in the older group (fig 9.3) where physical condition has been maintained by regular exercise the peaks and troughs are

not so evident. This effect of higher peaks and troughs reflects a reduction in the physical work capacity for the aircrew concerned, In anecdotal conversation where aircrew are involved in compressed periods of duty, e.g. mock exercise war games, necessitating the average flying hours to double or even triple the older group even with the advantage of experience lose the 'appetite' to fly sooner then their younger contempories.

When placed in reversed role situations (fig 9.3 and 9.2) the effect on efficiency is as expected, raised heart rate, inefficient movements (possible cause of artefacts on pilot trace). The constant work-load eventually results in overload and the resultant ejection. Both individuals were mentally and physically tired by the end of the sortie. This result was common to all such situations monitored. Despite the unusual workload demand the work rate could only be identified as moderate.

The influence of experience on efficiency is shown where two navigators with past recent experience on simulators as primary roles exhibit negligible work rate (fig 9.7 and 9.27).

Two pilots (9.11 and 9.23) in the older age group show heartrates during average workload of 116 and 128bpm respectively. Bothlead sedentary lifestyles with minimal exercise. They are both judged by their peers as competent and efficient to an above average level. However since the 'maximum' and the resulting' heart rate are fixed values at a given age and sex (Astrand and Rodahl 1970) the heart rate attained during work reflects the relative load, that is, the fitness of the subject. Possibly an exercise lifestyle would modify their arousal or work rate level to more desirable indices and make them more efficient.

With reference to fig 9.11 and 9.12 note the identical pattern recorded during the phase where the right hand landing gear sticks prior to landing. The more physically fit subject has much less elevation during this phase and thus less cardiovascular stress. There is a noticeable levelling of the heart traces with experience, exhibiting more efficient and controlled energy expenditure. The effect of inexperience is clearly seen in fig 9.13 ranging to the experience identified in Fig 9.27 It should be remembered however, that the heart rate maybe significantly influenced by factors other than the metabolic rate, such as ambient air temperature, emotional status, muscle groups used in the work, work position, amount of 'static' work involved, etc. Consequently the heart rate in practical work should not be interpreted directly in terms of energy expenditure but should rather be explained as the strain in the cardiovascular system.

Interpretation of these recordings do indicate a relationship between heartrate and physcial condition. Particularly in the older group (30-39) where exercise is neglected, with the resultant degradation of fitness, such individuals have heart traces similar to the young inexperienced aircrew. As a conseqence any benefit of experience is neutralized giving many 'peaks' and troughs as well as a raised arousal level to increase the stress on the cardiovascular system (fig 9.1, 9.11 and 9.23) Another possible conclusion may also be reached from this principle in that the younger group who simliary neglect their physical fitness maybe stressing their adaption capabilities reducing their overall efficiency (fig 9.6, 9.8, 9.10 and 9.16)

Analysis of the heart rates to grade the intensity of physical work in aircrew must derive the following:

a) Overall work intensity would be graded no greater than moderate (This is taking account of the average 10% increase from the "live "recordings")

b) Experience does have a strong influence in reducing workload stress.

c) Physical fitness also shows an influence in the work pattern ①

d) The arousal level rises as age increases suggesting possibly more emphasis is required on physical fitness to keep it within desirable levels.

e) A degradation of individual physical fitness results in an increase in stress due to impaired motor performance (see fig 9.18) ②

The transactional model of stress is graphically qualified by these heart-rate recordings. They show the individuality of the perception of stress and indicate the possible determinants as age, experience, psychic factors of attitude and motivaiton and physical factors of both physiological and mechanical components. When perception was poor because of false confidence, when the situation ultimately induced a response, the size of and effect of the stressful situation was invariably greater.

Also there is evidence that a high arousal rate is not necessarily detrimental to work performance in fact it maybe necessary (see fig 9.23). This again underlines the individual make-up of the stress phenomenon. Whether a more active lifestyle would lower this arousal rate but still maintain the individual

work efficiency is open to investigaton. Unquestionably a lowering of the heart rate to a more desirable rate would reduce the strain on the physiological systems of the individual.

Using the heart rate criteria for evaluating the psychophsiological reponse to stressful situations has endorsed much of the perceived stress and potentially stressful situation related in Chapter 2. The manoeuvre of landing and taking off as expected are readily identifiable with peak heart rates indicating high work rates with resultant stress influences. Also noticable during these two phases is the generally higher rates of the younger navigators (20-29) compared to the younger pilots. This emphasises the effect of the deprivation of the important factor which enhances the stress influence, that of poor physical feedback.

The mind has great influence over the body, and maladies often have their origin there.

Maliere (1665)

5. PSYCHOLOGICAL MAKE-UP OF AIRCREW

5.1 Introduction

As stated by Lager (1974) aircrew reliability is related to 'Behaviour' to a far higher degree than to 'Ability'. Reliability and "Behaviour" will in general be a function of wide variety of personality traits, of training and experience. Each individual is off course unique and continously changing. (1) 'Personality however, can be structured in a comprehensible number of syndromes', groups of traits or persons with a high correlation of descriptive variables with-in the group. If one or more of these characteristics have a significant variation in at least one "reliability" dimension then we will have a reliability or efficiency description and prediction.

Taking the above statements as a premise in any study of factors relating to aircrew efficiency particulary at an individual level, it was obvious the psychological factor was a most important ingredient in the relationship of health, fitness and stress and their influence on individual efficiency.

The problem which now arose was which personality inventory would (2) be most valid in measuring the various characteristics in an aircrew group. With reference again to Lager (1974) he chose the "Minesota Multiphasic Personality Inventory " (MMPI) which proved in his study to serve the purpose desired. But one major fault of the MMPI is that although a well established instrument it was oriented principally to the pathological features. While it can provide a significant amount of information at the syndrome level, it fails to deal with nonpathological features of

personality structure. In doing so , it misses out a significant portion of the total picture.

The 16 Personality Factor Questionnaire (16PF) was also discounted because although it did cover a span of normal personality functions some areas were still neglected. But an evolution of the 16PF did appear to be suitable, the Clinical Analysis Questionnaire (CAQ). The CAQ which was developed to meet the need for a single instrument that would simultaneously measure normal and pathological trait levels and provide a full, multidimensional profile of the individual.

The CAQ has 272 questions, 128 in part 1 of the test, which covers the normal personality structure, and 144 in part 11 of the test, which covers the depression and pathological traits. Part 1 or Form A is derived from the questions orignally used in the Form A of the 16 PF, approximately 50% of the questions are orignal 16PF questions but the remainder have been modified from other parts of the 16PF or totally new in concept. The Form B of or Part II (1) the CAQ is entirley new in concept, based on the reported clinical symptomology factors and refined over the years.

Its validity for this study is also supported by studies already carried out on groups with similar working stress situations, namely air-traffic control specialists (Karson 1967) (Cobb, 1968) and workers screened for work in nuclear power plants (Krug, (2) 1978). These professions require constant attention to detail occasionaly routine, but each has inherent stressful situations requiring quick thought in a crisis similar to flying. The CAQ also had the attraction of being administered either individually

or in a group. This permitted flexibility in administering the test. In addition there is no time limit although generally it will take approximately two hours for an individual to complete the two forms. The questionnaire booklet is enclosed as Appendix 4. .

5.2 Method

A sub-group of aircrew who participated in the work evaluation study (chapter 4) also voluntered to take part in the psychological assessment. The group consisted of 22 pilots and 16 navigators, all fixed wing aircrew. The mean age of the group was 29.63± 5.21 years.

Each individual at the conclusion of the recorded simulator sortie was given one test booklet and one answer sheet Appendix 4. . He was requested to complete the questionnaire soonest, and if possible at one sitting. If not possible to do both form A and B at one sitting they were requested to do them individually. In most cases the questionnaire was returned complete with-in 48 hours.

The answer sheets were scored by hand using the scoring template supplied, ensuring answers had been made to all questions. The raw scores are then converted to normative scores or stens (ie standard ten scores). Stens have a mean of 5.5 in the reference population , a standard deviation of 2, and a range between 1 and 10.

No questionnaire is immune from distortion whether it arises from voluntary or unconscious sources. With the belief that the best way to control conscious tendencies to distort is to help the examinees see that accuracy is to his or her advantage as much as

that of the examiner, Krug (1978) produced a self contained validity scale. This is based on a similar framework to the MMPI F scale. Details regrading this V scale are provided in the orignal research.

None of the 38 returns were invalidated using the protocol of a cut off score of 2 (ie classifying protocols with a V score of 3 or higher as invalid) This remarks highly on the test taking attitude of the group.

The normative scores were then recorded on the individuals record folder (Appendix 5) giving a graphic portrayal of the test data. In addition the scores were transferred to the second order worksheet where by using a simplified hand procedure of known validity coefficients the second order factors are calculated. The results can then also be graphically portrayed on the record folder. Second order factors do not give new information in addition to the primary scores but they do organise the information in helpful ways to aid interpretation.

5.3 Results and Discussion

When the Form A raw score means were compared with those of the standardization sample from table 4, significant (differences emerged on nine primary factors, namely, A,B,C,E,I,L,M,Q_1 and Q_4. The aircrew were lower on A (Warmth), higher on B (Intelligence), higher on C, (emotional strength), higher on E (Dominance), lower on I (Sensitivity), higher on L (Suspiciousness), lower on M (Imagination), higher on Q_1 (Radicalism) and higher on Q_4 (Tension).

Form B, the Clinical Factors, when compared with raw score means from the standardization sample in Table 2, significant difference were identified in eight of the twelve clincial factors, namely, D_1,D_2,D_3,D_4,D_5,D_6,P_p and P_s. As a group the aircrew were lower in D_1, (Hypochondriasis), lower in D2 (suicidal Depression), higher in D_3 (Agitation), lower in D_4 (Anxious Depression), lower in D_5 (Low Energy Depression), lower in D_6 (Guilt and Resentment), higher in P_p (Psychopathic Deviation) and lower in P_s (pyschological Inadequacy).

Analysis of the aircrew and the group norms with reference to the 16 Normal personality traits identify the aircrew as less warm than the average person (A-), a great deal more intelligent (B+) with more ego strength or emotional stability (C+) and more dominant (E+). They are less sensitive (I-), more suspicious (L+), lower in imagination (M+), more open to innovation, more radical (Q_1,) and higher in tension (Q_4).

TABLE 4 RAW SCORES MEANS AND STANDARD DEVIATION ON FORM A CAQ

SYNDROME		Normal * Adult Males (Av age 30)		Total Aircrew Group N=38		Aircrew (20-29) N=22		Aircrew (30-39) N=16	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
Warmth	A	7.73	2.88	6.05	2.48	5.91	2.61	6.25	2.28
Intelligence	B	6.33	1.49	7.16	.74	7	.74	7.36	.69
Emotional Stability	C	12.13	2.71	12.89	2.15	12.64	2.71	13.25	.83
Dominance	E	9.32	3.32	11.49	2.43	11.63	2.35	11.12	2.52
Impulsivity	F	9.26	2.89	9.36	2.39	9.91	2.07	8.63	2.60
Conformity	G	11.04	3.62	10.26	3.21	10.18	3.69	10.38	2.39
Boldness	H	8.97	4.12	9.79	3.74	10.91	2.39	9.12	4.17
Sensitivity	I	6.98	3.29	5.26	3.04	5.55	3.53	4.18	2.15
Suspiciousness	L	8.56	2.51	9.84	2.68	9.91	2.54	9.75	2.86
Imagination	M	8.69	2.77	6.79	2.50	7.55	2.06	7	1.94
Shrewdness	N	6.85	2.41	6.53	2.04	6.18	1.69	7	2.35
Insecurity	O	6.12	3.06	5.21	2.07	4.91	1.73	5.63	2.39
Radicalism	Q_1	8.13	3.21	9.21	2.21	9.09	2.43	9.38	1.87
Self-Sufficiency	Q_2	8.49	3.42	9.68	2.96	9.55	2.90	9.88	3.02
Self-Discipline	Q_3	10.17	3.17	9.26	3.08	9.64	3.36	8.75	2.54
Tension	Q_4	6.79	3.47	8.11	3.19	8.18	3.46	8	2.78

* From CAQ Manual Table 2.2 - N=488

Comparison within the aircrew group also show differences related to age. The older (30-39) group are higher in warmth (A+), higher in intelligence (B+) higher in emotional stability (C+), lower in dominance (E) and lower in umpulsivity (F-). Also as a group they are more conforming than their juniors (G+), more tough-minded tough-minded (I-), less suspicious (L-) and less imaginative (M-) Shrewdness is increased with age (N+), insecurity is also increased (O+) as is radicalsim (Q_1+), they are more self-sufficient (Q_2+) radicalism (Q_1+), they are more self suffiecient (Q_2+), self discipline is decreased (Q_3-) as in tension (Q_4-).

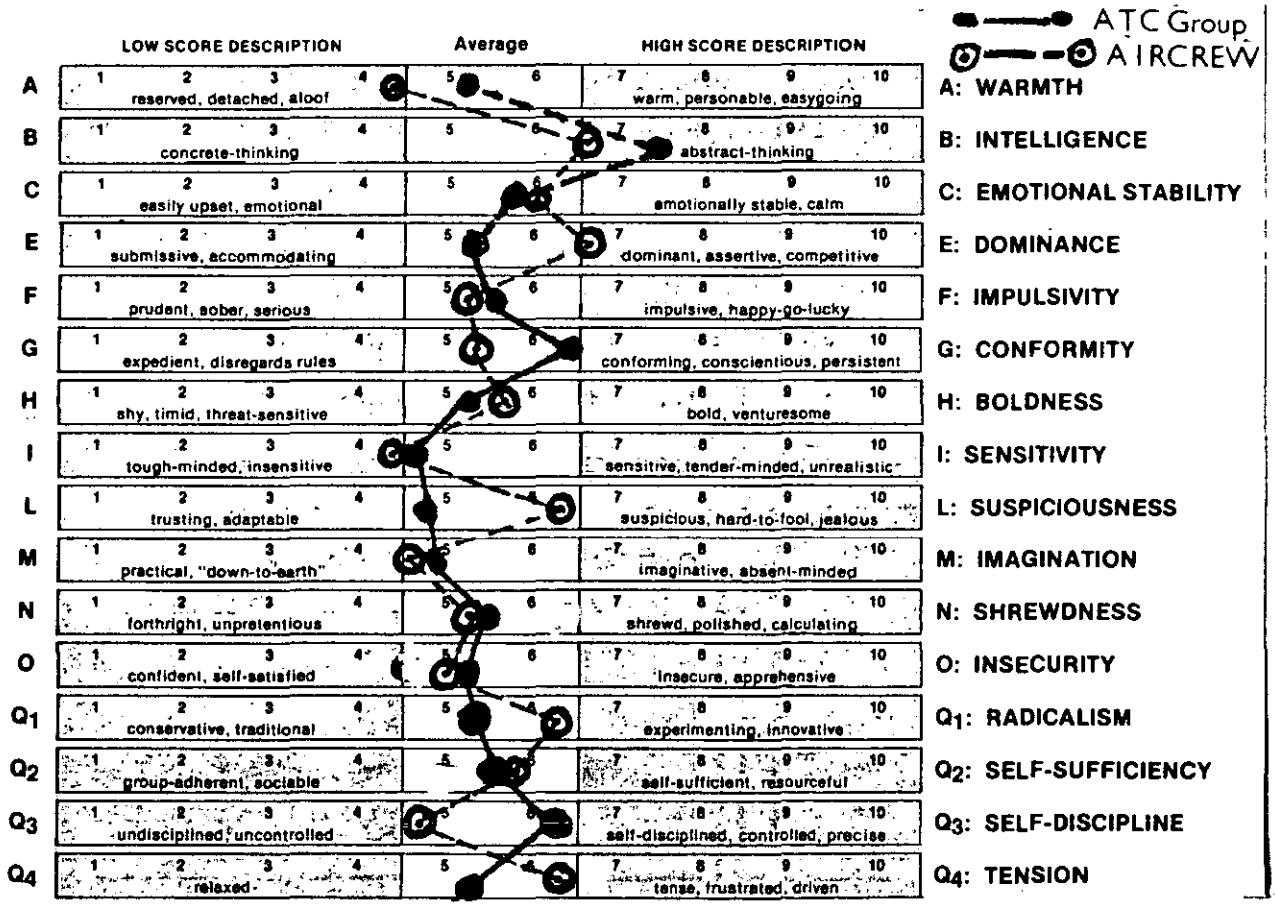
Much of the above changes can be attributed to both maturity and the effects of lifes experiences. Traits such as higher intelligence (B+), higher emotional stability (C+), higher dominance (E+), less impulsivity (F-), more suspicious (L+), more practical (M-), higher radicalism (Q_1+) and higher self sufficiency (Q_2+) as a group are of practical significance in what is desirable in aircrew. Equally encouraging is that as described above, those traits, and some not mentioned, which are of little practical significance, with age and maturity they also improve to the advantage of the individual.

An interesting feature on the primary factors is the higher tension factor (Q_4+). This is known as an 'id' (general ergic need ie energy excited in excess of the ego strength capacity to discharge it, and which is therefore misdirected, converted into psychosomatic disturbances, anxiety etc., and is generally disruptive of steady application and emotional balance. The level is higher in the younger group (20-29) and as cited by

Cattell (1970) this undischarged drive can be a function of the level of situational, environmental fustration and difficulty. This would be in accord with young, inexperienced aircrew having the pressures of training and success in an extremely demanding job. It is noted that as age increases on average this degree of tension reduces, possibly due to the increase in experience and natural reduction in energy. These also appeared to be an unvalidated relationship between physical fitness and the tension level.

In comparison with a study of air traffic control personnel by Karson and O'Dell (1974) the aircrew group are similar in personality make-up. This comparison is graphically portrayed with mean S-stens plotted in fig 10.

FIG 10 S-STEN SCORES – AIRCREW GROUP and ATC GROUP



The higher dominance (E+) in aircrew compared to the Air Traffic Controllers is significant but it is in accord with studies on airline pilots (Cullen and Yeagar 1980). Also the increased tension (Q4+) score by the aircrew is in agreement with studies on airman (U.S. Military pilot cadets in training) by Connery and Velhaver (unpub 16PF Handbook).

Some results in a study in the Australian Air Force (Want, 1959) suggested from a small sample that where E and H were loaded positively within the group it was not considered a recipe for successful training. It is interesting to note both traits are modified in this aircrew sample with age.

This certainly fits the sterotype of the fighting man compared to the airline pilot, high on independence, toughness, and dominance, and less responsible and conforming than the corresponding airline pilot, Comparisions with air controllers, who require and portray similar attributes to aircrew, show their personality traits to be much more alike to those of airline pilots then military pilots.

An interesting question is raised by this observation in that a sizable percentage of military air traffic controllers are failed aircrew. Possibly an identifiable weakness in a personality dimension is the cause of their failure since their physical aptitude in selection is well evaluated.

Looking at the Clinical Factors the more significant differences are that aircrew are lower in D_1, (Hypochondriasis), lower in D_2 (Suicidal Depression) higher in D_3 (Agitated Depression), lower in D_4 (anxious Depression). They are also lower in D_5 (Low energy), D_6 (Guilt and Resentment) lower in D_7 (Boredom and

Withdrawal), no significant difference in P_a (Paraonia), but higher in P_p (Psychopathic Deviaiton). Also they are favourably lower in S_c (Schyophrenia) and A_S (Psychasthenia) with a good level in the P_s (Psychological Inadequacy).

This presents a sound clinical picture of a healthy, outgoing personality, full of a feeling of worth and a sound picture of reality. He does have very little depressive influences in his approach to life. This makes an ideal balance with his primary factors and in comparison to the general population he is superior in almost every repect for the sort of work for which he has been selected.

FIG II COMPARISON OF THE SECOND-ORDER FACTORS BY AGE GROUPS

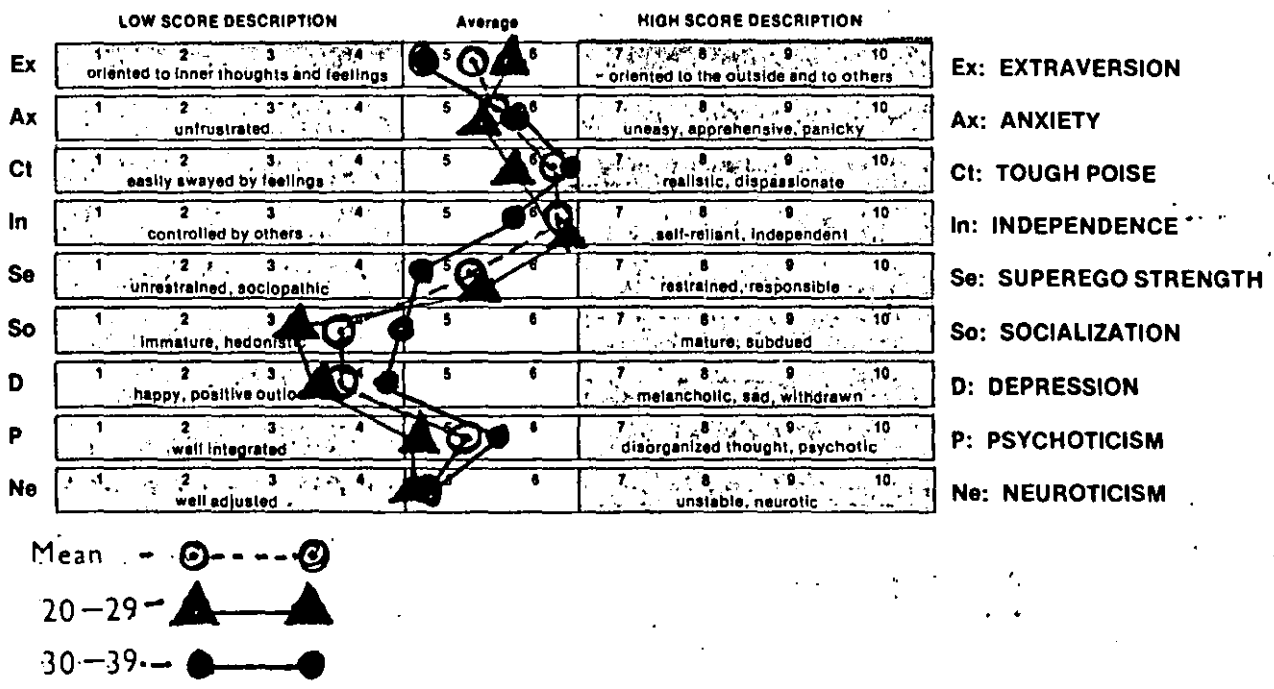


TABLE 5 - MEANS AND SD FOR CLINICAL FACTORS - Part B CAQ

	(488 = N) Normal Males		Total Aircrew		20-29		Aircrew(30-39)	
	M	SD	M	S.D	M	S.D	M	S.D
1. Hypochondriasis D_1	3.61	4.36	1.26	2.61	.36	1.15	2.5	3.43
2. Suicidal Depression D_2	3.06	4.22	.95	2.33	1.55	2.9	.125	.33
3. Agitated Depression D_3	12.39	3.17	15.26	3.42	16.1	3.5	14.12	2.93
4. Anxious Depression D_4	5.98	3.57	3.47	2.76	2.72	2.56	4.5	2.69
5. Low Energy D_5	6.31	5.82	3.63	3.90	3.91	4.99	3.25	1.30
6. Guilt & Resentment D_6	5.42	4.35	3.32	2.18	3	2.52	3.75	1.48
7. Bored Depression D_7	4.47	3.84	3.74	2.07	3	2.26	4.75	1.20
8. Paramoia D9	5.10	3.84	4.68	2.79	4.82	2.92	4.5	2.6
9. Psychopathetic Deviation Pp	15.28	3.56	18	2.25	18.73	2.42	17	1.5
10. Schmophrenia Sc	4.36	3.82	3.37	2.98	3.27	3.54	3.5	1.94
11. Psychosilenici As	6.51	4.11	5.74	3.45	5.45	3.94	6.13	2.57
12. Psychological Inadequacy Ps	4.80	4.53	2.37	1.75	2.27	1.81	2.5	1.66

By factor analyzing the correltions among the 26 primary scale scores it is possible to find the second order factors. The results are portrayed graphically as Fig 11 above and given in detail in table 6.

TABLE 6 - SECOND ORDER FACTOR COMPARISONS IN AGE GROUPS

	EX	AX	CT	IN	SE	SO	D	P	NE
Mean	5.34	5.63	6.13	6.16	5.18	3.92	3.97	5.1	4.91
S.D.	±1.54	±1.48	±1.49	±1.48	±1.71	±1.32	±1.26	±2.01	±1.89
(20-29)	5.67	5.56	5.99	6.31	5.34	3.49	3.68	4.79	4.72
S.D.	±1.52	±1.71	±1.63	±1.51	±1.84	±1.11	±1.46	±2.27	±1.52
(30-39)	4.88	5.73	6.34	5.95	4.97	4.51	4.37	5.53	4.97
S.D.	±1.45	±1.06	±1.23	±1.40	±1.49	±1.14	± .76	±1.51	±2.22

Comparison of the results underlines the traits already identified in the 26 primary scales. Extraversion (Ex) is not abnormal but significant difference is seen between the age groups, it is diminished with age. The high scoring tough poise (C_T) is an indication of alertness this also noticibly reduces with age. High scoring independence is another desirable trait. An interesting feature of socialization (So) scale is that it is diminished with age. The high scoring tough poise (Ct) is an indication of alertness this also noticably reduces with age. High scoring idependence is another desirable trait. An interesting feature of the socialization (S_o) scale is that it moves to the right (S_o+) indicating what would be expected, maturity with age. The areas of D, (Depression) P, (Psychoticism), and Ne (Neuroticism) all portray the same picture

of a contented, well integrated individual.

As found by a number of studies during the evolution of the CAQ the general pattern by correlations with age identify a decline in pathology levels over the years and an increase in behaviour control.

The CAQ when compared with the MMPI scales correlates favourably with many of them but others only correlated to a moderate degree. This in no way detracts from its validity as an instrument for measuring personality traits particularly at a non-pathoalogical level. The weakness at present with the CAQ is the constraint of having only a few studies for comparision and validaton. Much analysis of primaries are done by comparing scores with studies using the original 16 PF. It is hoped that this part of the study will broaden the area of comparisons for use in future studies employing the CAQ.

As an instrument to identify and clarify personality traits in aircrew it is concluded that this has been achieved by use of the CAQ. This will be of assistance in predicting behaviour, and give guidelines on modification of pathological characteristics, possibly through an increase in physical activity.

Recent studies by Welteman and Stamford (1983) have shown that there are a number of advantageous effects on the psychological characteristics of an individual by regular exercice. They report regular exercisers to relate not only a feeling of being healthier but also and enhanced self-image.

Individuals who ran regularly spoke of their feelings of well being stemmed largely from the psychological rather than the physical success. Other studies have shown vigourous exercise

may act as a release of tension and anxiety psychologically and release muscle tension physically. Running experiments have also recently identified a relationship between depression and active and sedentary groups. Lobstein (1982 unpub) reported evidence of the depression component of emotional stability was raised in sedentary people. In a controlled exercise group he noticed significant reduction in this component over a 4 month period.

Exercise may provide a series of inbuilt rewards giving a sense of accomplishment and emotional pleasure. This could be looked on as a balance to life from the high risk task of flying with its inbuilt stresses, anxiety and tensions physical and pyschological.

Reduction of these muscle tensions, anxiety and depression by exercise may then promote relaxation and increase deep sleep. It has been well reported that chronic insonmmia is a main ingredient of psychological distrubances, more deep sleep may help allevaite those probelms.

A good self esteem is another strong deterrent to psychological problems. Self image particulary physical appearance is intimately related to self concept, so improved fitness usually results in improved self esteem. In my experience problems of self-esteem were more prevalent in the 28 + age group with refernce to aircrew. When these were related to physical factors the over riding concern was the possible threat to their flying status, particulary medical implications.

But as identified in this part of the discussion aircrew as a group have few noticeable weaknesses in their psychological make-up. However there are also situations where individual

weaknesses maybe strenghtened by modification of lifestyle and participation in a regular exercise session. One aircrew charateristic which may benefit from a more defined exercise lifestyle is the dimension of 'ergic tension. There is no evidence of too much disruption of the overall character and personality of aircrew but they do as a group have a preference for 'letting of steam' in a destructive manner. Destruction of Mess pianos at various functions is a frequent activity peculiar to aircrew.

Therefore in summary vigourous exercise - such as running - seems to offer a variety of psychological benefits. The implications and any considered advantages to aircrew will be discussed in the following Chapter. In addition any considered relationship between stress, fitness and health will be offered highlighting any significant personality components influencing the relationships.

Since we cannot promise our selves constant health let us endeavour at such temper as maybe our best support in the decay of it.

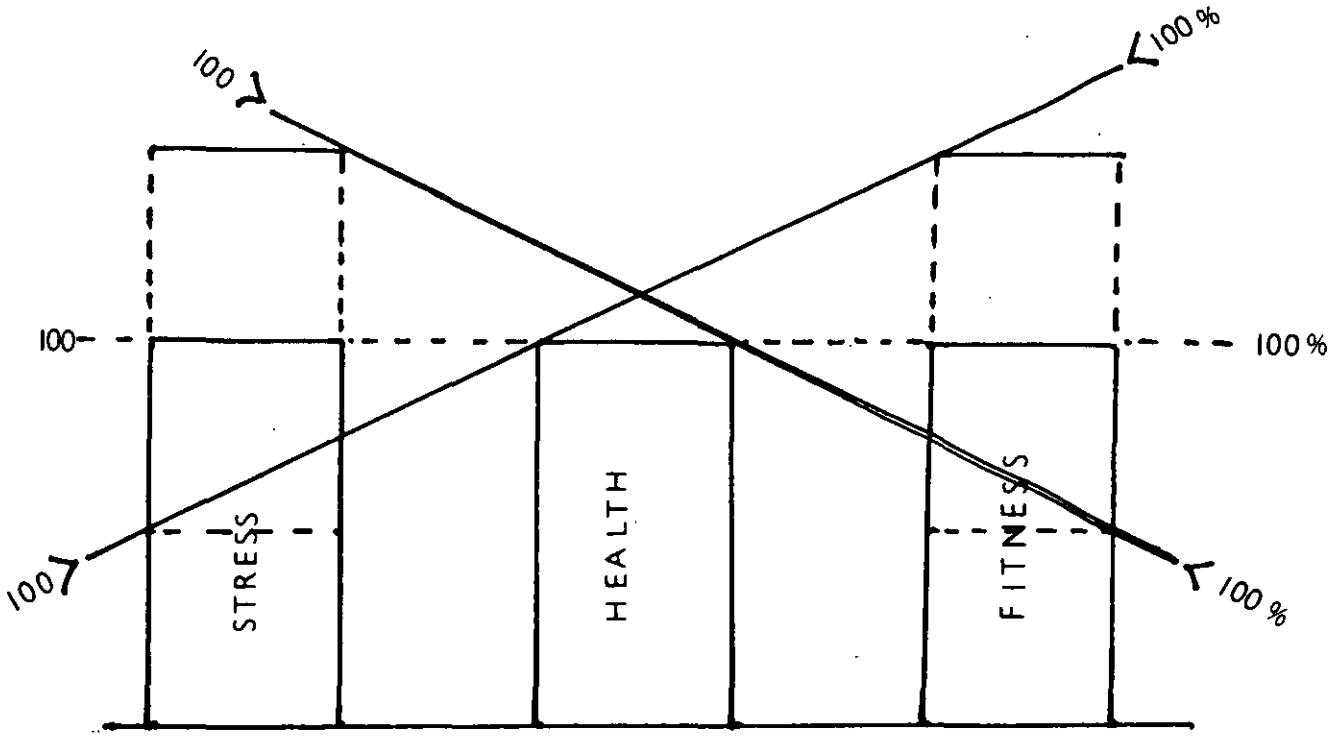
Richard Steele (1711-12)

6 Discussion

6.1 Introduction

This study began with the premise that the factors of stress, health and fitness were individual variables. In additon although considered independent it was also felt they did have influencing effects on each other. This study has identified a number of such inter-relationships and the following model is proposed as a general thesis for these relationships. From this model the discussion will extend to explain the relationships between the independent variables.

FIG 12. INDIVIDUAL EFFICIENCY MODEL



The model is identifiable as three separate and variable manometers. When each manometer is in harmony for any one individual, with no adverse influence between them, it is considered the optium level of efficiency ie 100%. Undue emphasis on any of the three factors above or below this individual level will result in disharmony with the resultng degradation in performance and efficiency ie < 100%.

Standards being individual are self defining thus necessitating an evalution of the subject both psychologically and physically. This approach does not negate general standards in those two spheres but suggests they should be interpreted as guidelines. Individual optimum levels may occur when individual factors have scores above or below general population standards. This approach does not contradict the model of factors affecting physical performance capacity by Åstrand and Rodahl (Fig 1) it could be considered implict in it.

Military fitness and the factors affecting it are normally related in general terms often resulting in remedies which are too much or too little for individual requirments. By relating the following aspects of stress, health and fitness in this study of aircrew it is hoped to show an individual appraisal and prescription is necessary.

6.2 Stress

Stress was defined as an individually perceived phenomenon with its roots firmly in the psychological not physical response. Potentially stressful situations and perceived situations were discussed in Chapter 2. Many of these accepted stresses of

flying were endorsed by both the heart-rate criteria and also the perceived stress evaluation form which the aircrew completed at the conclusion of a simulator sortie.

What was shown to be true by this part of the study is that stress is individual in character. However generalizations on the labelling of stressful situations were possible by analyzing the data gained in this section. What was also identified was the complexity of the stress phenomemon. When comparisions were made between the same individual and similar sorties, readings and evaluations were not always identical. Different time periods, after a number of other sorties, different crew memeber, domestic problems and so on would influence the delay or the speed of the onset on stress. Thus even at an individual level generalizations cannot always be reliable.

Training and experience were shown to be strong influencing factors in reducing the impact of stress on individual performance. In measuring work performance, results on the younger group (20-29) indicated raised arousal heart-rates compared to the older group (30-39). This suggests inexperience producing increased demands on the physiological response in the younger group. The 30-39 year old age group showed in general arousal rates lower and more even than their younger contemporaries.

When individuals were reviewed in respect to their activity status and physical fitness more differences were noted. In the physcially fit younger individual although the arousal rate was higher than his more experienced of unfit peer, his work pattern was seen to be better and more efficient with fewer peaks. It

showed ready adaption to most stressful situations. Where-as the unfit individual in the older group generally displayed recordings with deeper peaks and troughs neutralizing the advantages of training and experience. Such traces showing maladaption would obviously be indicative of inefficient energy (1) expenditure in both groups. In addition in the older group where poor physicial condition was evident it would result in the arousal level rising to similar levels of the inexperienced aircrew.

These inefficient patterns relating to enery expenditure in the older aircrew would in a situation of sustained flying bring on (2) the feeling of 'lack of appetite' to fly sooner than in the younger group. This could be determined a fatigue situation. Fatigue obviously would be a component in the complex equation of stress influencing the individuals performance.

The psychological evaluation and the factors which modify the stressful influences on aircrew were also studied. The findings from this part of the study in general favoured the aircrews resistance to stress. They identified inherent personality characteristics which would be desirable and necessary to assist them in coping with the stressful nature of their task. In particular characteristics of independence, toughness and dominance were high in the group. Emotional stability (C) was not as low as compared to a similar study on a group of air traffic controllers but it fell within normal parameters. But an interesting feature of this component, which is useful as an indicant of an individuals resource to with-stand stress, is that emotional stability improved with age in the groups.

Increase in age was also a significant factor in a direct relationship of an increase, in hypochondrias (D_1). Also significant with this factor was that a higher level was found in individuals who had experience of some physical ailment. Such situations seemed to heighten the individuals stress, particularly in health matters, due to the preceived threat of becoming unfit to fly.

Depression was not a significant deviation in either age group. However it was more noticable in the younger age group. Whether as suggested by studies earlier that a more active lifestyle would help to modify this factor is open to investigation.

Extroversion as would be expected and as stated earlier was seen to be higher in the younger age group. This could be considered a desirable modifying factor in minimising perceived stress with

youthful bravado, obscuring the individuals perceived capability. But another side to this argument may be put in that by obscuring his perceived capability he may find by the time he perceives the stressful situation his coping response maybe inadequate.

In the older group a reduction in the level of alertness (Ct) is also evident. Possibly evidence of the reason for the quicker 'loss of appetite' for flying. Would enhanced physical condition improve this deterioration and remove a possible ingredient to a stressful situation? A number of studies suggest such improvement with improved physical condition.

The factor of maturity obviously improves with age reflecting experience and training. This characteristic will similalry increase the resource of suitable coping responses. What is common to both age groups is a high level of 'ergic' tension if not controlled or relieved could prove disruptive. Again exercise could prove to be prophylactic in providing relief.

As mentioned previously Lager (1974) stated that aircrew reliability is related more to behaviour than ability. In that stress has its roots also in the psychological it is therefore considered that investigations into advantages or otherwise of physical fitness on flying performance may in future give some emphasis into the psychological benefits in addition to the physiological.

6.3 Health

Health, in particular good health means 'soundness of body and freedom from disease. This state of well being has physical and mental components. A number of factors influence both our present and future good health. These include age, sex, inherent factors, blood pressure (BP), body fat and factors of lifestyle. Some can be self-modified; others cannot. As with fitness and stress our needs to maintain good health are specific and individual, due to the variety of influencing factors.

All aircrew are thoroughly screened medically before initial engagement into the Air Force and as stated earlier this is reflected in the low level health risk pattern in the study group. Self initiation of unhealthy lifestyle factors such as smoking, minimal exercise, poor diet and inability to cope effectively with stresses are the precursors of their ill health.

In evaluating the intensity of physical work carried out by the aircrew it was found to graded no greater than moderate. In general, work intensity would unarguably be considered sedentary by nature. The working situation is a large seat on which from start to finish the aircrew are harnessed quite firmily over the torso, and leg gaiters restrain the legs. Physical movement is very limited and physiological responses are normally intiated by external environmental pressures such as 'G'forces or internal psychological preception of a stressful situation.

The main effect of the sedentary nature of the job on their

health is an increase in body fat. The average weight of the group in relation to height was not significantly above the normal. Their weight statistic did not relect obesity in the group. But the free fat mass of the group, on average, was significantly higher than the desirable level by as much as 50% in some cases. This would not only affect physilogically responses such as aerobic efficiency but mechanical efficiency must also be impaired.

Smoking within the group was not high at less than 25%. But what is interesting is that the largest number of this percentage were to be found in the older age group (30-39). This possible anomaly maybe explainable in suggesting this to be a generation who started smoking prior to the recent deluge of anti-smoking health education. An encouraging fact of the group smoking habits were that pipes were more in evidence than cigarettes, many modifying the habit to-wards giving it up. It could be argued that the increase in smokers in the older group (30-39) could be doing so as a stress reducing strategy. To further complicate the argument the senior executives (40-49) although not a statistically reliable number (5) did not smoke at all . A longitudinal study over a number of years may produce the solution.

Active exercise in the group as a whole was low at just over 50%. When looking at the group longitudinally it was found to diminish with age with a significant drop-off in the senior group (40-49) to only 40% participation. This important factor of a healthy life style in addition to smoking were the two main components in raising the health risk factor.

Common virtually to all the health factors throughout the three age groups was a steady increase both individually and in groups. Overall risk status rose from low risk in the younger group (20-29) to average in the senior group (40-49). This change of health status is avoidable by suitable modification of lifestyle and implementation of a positive exercise or activity programme.

6.4 Fitness

Fitness and in particular physical fitness is related to task. This fact is most frequently either intentionally or unintentionally overlooked in studies and definitions of military fitness. Most investigations in to military fitness have tended to fall into one or other of the areas of cardio-vascular fitness or into even more specific areas of physiological adaption. This specialism has resulted regularly in failure of many findings to be reviewed in a holistic approach. Many of these isolated approaches then produced serious statements which are blindly accepted, delaying and diverting progressive approaches. An example of such a diversion has already been cited in the introduction with reference to 'G' tolerance. Many physiological studies have frequently suggested physical fitness was not advantageous to -wards 'G' tolerance. But the recent study by Epperson (1983) has endorsed previous evidence that muscle tone rather than aerobic endurance influences the bodys anti G system. So just as fitness is specific and task related, studies must be equally specific in their pronouncements. To generalize in such a situation is wrong and not constructive.

This muscle tone is not only important, as has been suggested, for increased 'G'tolerance, but there is evidence from this study that it is important for improved mechanical efficiency. In my experience with the aircrew neck and back strain were prevalent. Improved muscle tone could allieviate many of these problems by increasing flexion and overall mobility.

The aerobic efficiency of the personnel studied with few exceptions, was of a desirable, if not above desirable standard. Much of the evaluation of aerobic fitness in aircrew in the past has been by using a test involving a set run and time relationship. Invariably the results have not reflected well on the fitness of aircrew. My suggestion is that the test identifed either the motivational attitude of the aircrew tested or the poor mechanical efficiency of the ability to run. In many instances probably both factors were influential in producing a poor result. Those that did not reach the aerobic guidlines used in this study would in virtually every situation do so merely by reducing his free fat mass back to ideal dimensions.

As originally stated 'fitness' also has a mental component and the need for this psychological fitness cannot be overstressed. The resource to cope in potentially stressful situations depends largely on this mental fitness. The psychological make up discussed earlier on factors of depression, emotional stability , alertness and others may all as previously suggested have much to gain from enchanced physical fitness. Self esteem alone maybe enhanced by regular physical fitness and greater body awareness. Tensions which are closely associated with body and muscle tensions as suggested may derive benefits from vigorous

physical exercise.

The advantages of the individual approach to evaluating fitness are many . Fitness is specific and like stress it is individual in nature. The variables of background, motivation,body type, pre-disposition to exercise, the permutation of personality factors and others are all ingredients in individual fitness. General prescription will affect these variables with a range of emphasis, with the result individual fitness will be just as varied as in the begining. By giving individual analysis, by defining individual 'strengths' and 'weakness' and presenting it in an educative picture indivdual understanding will be greater. It would be hoped through this understanding personal motivation would be increased to follow the prescribed modifications and remedies suggested. Prescription of this individual nature would aim to harmonize for the individual his factors of fitness, health and stress management.

There is also evidence, shown in the results of the evaluation of physical work capacity, that enhanced physical fitness provides improved ability for increased work capacity. Åstrand and Rodahl (1977) have previously stated that there is a high correlation between maximal oxygen uptake and total work output, with superior fitness allowing work to be performed longer, and at a higher fraction of the maximum aerobic capacity. This requirement for aerobic fitness in aircrew has regularly been discounted because they are rarely required to carry out arduous physical tasks, particularly for long periods of time. However, this study has shown that sustained periods of duty (see fig 9.1)

where the individual is experienced but poor in aerobic fitness and complaining of fatigue as a result of two previous live sorties, shows constant adaption throughout the simulator sortie. A pilot of similar experience (see fig 9.3) and also after two sorties, one live one simulated, but aerobically fit shows a reasonably even trace in comparison. Aerobic fitness in aircrew has been regularly discounted mainly because such studies showed very little advantage of physiological enhancement. Consideration should be given more importantly to the delaying of the on-set of fatigue which as an ingrediant of individual stress perception has both physiological and psycholiogical consequences.

The argument against aerobic fitness as a necessity is therefore only valid when physical work loads remain low. But as shown in this study the work load can be, even when low, accumulative. Regular activity was seen to combat this situation and aid maintenance of efficiency. Also the work stress level or arousal level was identifiable in the unfit older group to be similar to the inexperienced young contemporary. This would give raised energy expenditure ratios on this group possibly in excess of their resouces; another suggested reason for their feeling of fatigue and loss of appetite for further flying. In addition studies already mentioned in the introduction have evidence of both increased tolerance to heat stress and increased survival potential to cold stress in individuals who were physically fit. These are two major potential and preceived stress threats involving aircrew.

Physical activity must also be regarded as an important

component in producing a balanced lifestyle. Recreation is an important feature of aircrew rest periods and in an educative framework this objective should be emphasised. The connotation of recreation and sport regrettably dissuades many aircrew from participating in an exercise lifestyle. Through regular participation and involvement in exercise and an individual gains in-built rewards by attaining personal objectives and emotional pleasure. This will serve to reinforce self-image and self esteem. Experience has shown regular exercisers in the group displayed generally a more positive attitude to both their life and flying task.

In summary by returning to the theoretical model of efficiency and the related factors of stress, health and fitness proposed in the introduction, a number of over-lapping influences are identifiable. The factors of stress and fitness can be increased through the optimal level to produce disharmony where-as disharmony will only occur in the health factor when the individual optimum level is not achieved. There is frequently mentioned instances of individuals being in poor health but fit enough to complete a task and also being healthy but unfit. What must be considered in such states of disharmony is the influence on the stress component. Such situations will unquestionably affect the stress component and result in a inefficent response. The finite parts of the three components are shown in Fig 1 and show the stress and health factors to influence the service functions (Physical fitness). What the diagram does not show is the transactional nature of the whole process as defined by Cox

and Mackay (fig 4). However, implict in the model at Fig 1 is the individual nature of these factors further hypothesised by Cox and Mackay in defining stress, and endorsed in all aspects by this study.

Disharmony, preventing attainment of an optimal level within a factor can be caused by incongruity in that factor, or influences from the two other factors, singly or as a pair. By evaluating the individual on all three aspects it is possible to find if disharmony exists and prescribe modification which will produce a harmonious response. Such prescriptions are then both individual and specific to task.

Mechanical efficiency must also be considered an important part of physical fitness in addition to both physiological and psycholoical ingredients. The poor mechanical efficiency shown by the individual with a wrist injury (Fig. 9.18) maybe considered an extreme example . However the frequency of muscle trauma in the back and neck muscles of aircrew do suggest more investigation towards achieving fitness exercise prescription specific to the task.

Regimen is superior to medicine, especially as, from time immemorial, out of every hundred physicians, ninety-eight are charlatons.

Voltaire (1764)

7 Conclusions and Recommendations

This study identified the three factors of stress, health and fitness in a group of fast-jet aircrew. The relationships between the three factors were found to be complex, individual in nature and variable in influence. Each factor had both psychological and physiological components.

Physical fitness in a military definition has placed emphasis on cardio-vascular function and efficiency as its criteria. The findings in this study showed cardiovascular efficiency (aerobic efficiency) to be on average within or above desirable limits. The methods used were more individual and more specific than the frequently used set-time shuttle-run test. The aircrew considered this approach more interesting than the group run test with its connotation of athletics and competition.

Similarly, individual measurement and evaluation produced results showing %-body fat and not overweight relative to standard ht/wt tables to be a problem for aircrew. The inherent sedentary nature of their job, plus on the ground a large proportion of their job may be at a desk or waiting to fly, is the precursor of this situation. A possible solution is a work-out area beside the main crew room as the Sports Centre is often distant and inaccessible during the aircrews' spasmodic periods of work. The QRA hangerette where duty periods are 24 hours, often with no flying, could make such a facility well utilized.

One of the main problems of these long periods of inactivity was said to be boredom. This underarousal produced symptoms of fatigue and strain which are not desirable at the start of what could be a long sortie.

There is evidence that the more physically fit aircrews work more efficiently and with less strain on their cardiovascular system. There was no evidence of fitness improving flying ability unlike training and experience. However, where those two factors were evident and the individual was also fit the capacity to work efficiently and longer was noted.

Inactivity leads to poor muscle tone and higher levels of body fat. This situation tends to be the cause of many of the back and neck conditions found in aircrew. Many of these muscular problems might be prevented by better and more regular muscular activity using exercises related to their tasks.

The group studied were broken into age ranges, giving a pattern of results across the group. Although the backgrounds, personality lifestyle etc. across the group were similar it would still be necessary to do a longitudinal study to establish the patterns identified in this present cross-sectional study to be reliable in describing individual aircrew.

The provision of the health and fitness profile inclusive of personal consultation and advice was greatly appreciated by the aircrew. Such information and advice is normally available only from the medical officer and would normally be regarded as a threat that their fitness to fly was likely to be scrutinised. Thus there is a place for the physical educationist in this role which broadly covers health and physical education, both of which he is well qualified to cover. Those involved in health promotion programmes have been handicapped by the lack of a way to demonstrate the quantatative and interactive nature of risk-taking behaviour. People are not strongly inclined to act against

something they think will affect them only in the distant future. Aircrew fall into this category of people. A computer program has been developed as a product of the health and fitness profile which, by giving visual displays of evaluations of the tests and interactions, provides good motivation to keep fit. Again a longitudinal study is necessary to monitor if this initial success in motivating individuals to modify lifestyles continues.

Most problems of health impairment have been shown in this study to be self-initiated which strengthens the need for an individual approach to evaluation and education. Since medical screening ignores many of the problems associated with lifestyle, behaviour and ill health developing until after their flying careers are completed, this area of education has been neglected. This situation should now be remedied because, as shown by this study, there are gains to be made in efficiency now. The fuller understanding given by this approach gives knowledge and motivations for affecting lifestyle changes with consequent influences on all three factors of stress, fitness and health. As a group pscyhologically they were identified as having personality factors ideally suited to the task. However, there was evidence of health and fitness factors influencing some of these personality traits. This underlines the psychological relationship between those two factors, further emphasising the broader involvement of health and fitness.

Stress was found to be a psychological process affected by both internal and external factors. Physical fitness will enhance an individual's ability to cope by both modifying internal and externa

ingredients of individual stress. These modifications as a result of these relationships have been discussed in this study. Claims for physical fitness enhancing and improving health, giving resistance to psychological and physical stress and fatigue are not new. Much of the literature in support of these claims has been reviewed and the complex and variable relationships which do exist between stress, fitness and health have been discussed and defined in this study. Therefore, in conclusion it is recommended that perhaps more preventative medicine involving individual appraisal and prescription on these three factors should be carried out. This would ensure that individual 'fitness' was related to individual tasks.

Treble – One Squadron – 111 Sqn

"Take – Off" 170 mph – Mach 2

8. "THE TREMBLERS".

REFERENCES

ALLEN, D. W. (1980)

Prospective Medicine - Health Status Assessment and Lifestyle.

Australian Journal of Sports Medicine. Vol 12 (1); 2-10, 1980

AMERICAN COLLEGE OF SPORTS MEDICINE, (1976)

Guidelines for Graded Exercise Testing and Exercise Prescription.

Lea and Fiebiger, 1976

AMERICAN COLLEGE OF SPORTS MEDICINE, (1978)

'Position Statement on the Recommended Quantity and Quality of Exercise for Developing and Maintaining Fitness in Healthy Adults'.

Medicine and Science in Sports and Exercise.
Vol 10: 7-10, 1978

ANDERSON, A. L. (1947)

The Motivations of the Flyer and his Reactions to the Stress of Flight.

Journal of Aviation Medicine 1. 1947

ANDERSON, K. L., MASIRONI, R., RUTENFRANZ, J. and SELIGER, V. (1978)

Habitual Physical Activity and Health.

World Health Organization, Copenhagen.

ANDREASSI, J. L. (1980)

Psychophysiology.
Human Behaviour and Physiological Response.

Oxford University Press.

APPLEY, M. H., and TRUMBELL, R. (1967)

Psychological Stress.

Appleton - Century - Crofts New York (1967)

ASTRAND, P. and RODAHL, K. (1977)

Textbook of Work Physiology. 2nd Edition

McGraw - Hill, Inc, 1977

ASTRAND, I. ASTRAND, P-O., CHRISTENSEN, E.H., and HERMAN, R. (1960)

Circulatory and Respiratory Adaption to Severe Muscular Work.

Acta Physiology Scandinavia. 50:254-258, 1960

ASTRAND, P-O. (1972)

The Physiology of Maximal Peformance.

Modern Medicine. 563-570 1972

ASTRAND, P-O., RHYMING, I. (1954)

A Nomogram for Calculation of Aerobic Capacity (Physical Fitness) from Pulse Rate During Submaximal Work.

Journal of Applied Physiology. 7: 216-221, 1954

BALKE, B. and WARE, R. W. (1959)

An Experimental Study of 'physical fitness' for Air Force Personnel.

ARMED FORCES MEDICAL JOURNAL, 10: PP 675-688

BANNISTER, E. W., BROWN, R. S., LOEWEN, M. P. E., NORDAN, HC. (1967)

The RCAF 5BX PROGRAMME - A Metabolic Evaluation.

Medical Services Journal of Canada, Vol 23: 10, 1240-4, 1967

BILLINGS, C. E., BASON, R. and GERKE, R. J. (1970)

Physiological Cost of Pilotina Rotary Winged Aircraft.

Aerospace Med. 41, P256 - 258 1970

BRIDGES, P. K (1971)

ATTENTION AND AROUSAL: Some Factors Influencing Physiological Responses to Arousal.

Paper presented at conference of British Society of Sports Psychology - University of Leeds 1971.

BROADBENT, D. E (1971)

Decision and Stress.

Academic Press, 1971

BURKE, E. J. (1979)

Individualized Fitness Programme Using Perceived Exertion for the Prescription of Healthy Adults.

Journal of Physical Education and Recreation. November, 1979

BURKE, E. J. and HUMPHREYS, J. H. L. (1982)

Fit to Exercise.

Pelham Books Ltd., 1982

BYRD, R. and COLLINS, M. (1980)

Physiologic Characteristics of Fire Fighters.

Amen. Corr. Ther. Journal - July - August, 1980

Armed Forces Medical Journal. 10, 675-688, 1959

CATTELL, R. B., EBER H. W. and TATSUOKA, M. M. (1980)

Handbook for the Sixteen Personality Factor Questionnaire. (16 PF)

Institute for Personality and Ability Training, Inc.

CINK, R. E. and THOMAS, T. R. (1981)

Validity of the Astrand - Rhyming Nomogram For Predicting Maximal Oxygen Intake.

British Journal Sports Medicine - Vol: 15, No 3, PP. 182-185, September, 1981

COBB, B. B.

Relationships Among Age, Experience and Performance of Air Control Specialists.

Aerospace Medicine, February, 1968 PP 120-124

COLBURN, H. N. and BAKER, P. M. (1973)

Health Haryard Appraisal - A Possible Tool in Health Protection and Promotion.

Canadian Journal of Public Health, Vol 64: PP. 490-492, 1973

COX, T. 1978

Stress.

The MacMillan Press, 1978

COOPER, K. H. (1966)

Flying Status Insurance.

Aerospace Safety. P8-9 March, 1966

COOPER, K. H. (1970)

The New Aerobics.

M. Evans and Company, New York, 1970

COX, T. (1975)

The Nature and Management of Stress.

New Behav. 2, 493 1975

COX, T., and MACKAY, C J (1976)

A Psychological Model of Occupational Stress.

A paper presented to the Medical Research Council meeting Mental Health in Industry. London. November, 1976

CULLEN, J.F., and YEAGER, J C (1980)

Air Industry Personnel Profiles Published in 16PF Handbook

I.P.A.T., Inc. 1980

DAVIES, C. T. M. (1968)

Limitations to the Prediction of Maximum Oxygen Intake from Cardiac Frequency Measurements.

Journal of Applied Physiology 24: 700-706, 1968

DAVIES, D. R. and KRKOVIC, A. (1965)

Skin Conductance, Alph Activity and Vigilance.

American Journal of Psychiology. 78, 304-306, 1965

DAVIS, D. R. (1948)

Pilot Error.

Air Ministry Publication, AP. 3139A, (London: HMSO)

DAVIS, P. O., DOTSON, C. O. and SANTA MARIA, D. L. (1982)

Relationships Between Simulated Fire-Fighting Tasks and Physical Performance Measures.

Medicine and Science in Sports and Exercise.
Vol 14: No 1, PP. 65-71, 1982

DOBELN, W. von ASTRAND, P. and BERGSTROM, A. (1967)

An Analysis of Age and Other Factors Related to Maximal Oxygen Intake.

Journal of Applied Physiology Vol: 22, No 5, 1967 P.934

DURIN, J. V. G. A., and WOMERSLEY, J. (1973)

Body Fat Assessed from Total Body Density and its Estimation from Skinfold Thickness: Measurements On 481 Men and Women Aged from 16 to 72 years.

British Journal of Nutrition 32, PP. 77-97 1974

EICHNA, F. W., BEAN, W. B., and ASHE, W. F. (1944)

Comparisons of Tests of Physical Fitness.

Fort Knox; Army Ground Forces Medical Research Laboratory.
March 10, 1944, Project No 5, S-P No 5-29

EPPERSON, W.L. (1983)

The Effect of Physical Conditioning on Positive G. Tolerance

Circulated by D/IFS (RAF) 60/23 dated 14 April 1983

EYSENCK, H. J. (1947)

Dimensions of Personality.

Kegan Paul, London, 1947

EYSENCK, H. J. (1967)

The Biological Basis of Personality.

Thomas, Springfield, 1967

FENTEM, P. H. et al (1977)

Serminar on Jogging, Health and Exercise, Organised by the Sports Council E and W. Midlands Regions. Held at Birmingham University February 1977.

FLEISHMAN, E. (1964)

The Structure and Measurement of Pysical Fitness.

Englewood Cliffs N. J. : Prentice - Hall Inc., 1964.

FOX, S. M., NAUGHTON, J. P., and GORMAN, P. A (1972)

Physical Activity and Cardio-Vascular Health.

Modern Concepts of Cardio-Vascular Disease.
16 June, 1972

FRASER D. C. (1953)

The Relation of an Environmental Variable to Performance in a Prolonged Visual Task.

Quarterly Journal of Experimental Psychology 5, 31-32 1953

FROELICHER, V. F. (1977)

Does Exercise Conditioning Delay Progression of Myocardial ischermia in Coronary Alteroscleratic Heart Disease.

Cardiovascular Clinics 8: 11-31, 1977

FURNEAUX, W. D. (1962)

The Psychologist and the University.

Universities Quarterly, 17, 33-47 1962

GETCHELL, B., (1976)

Physical Fitness a Way of Life.

John Wiley and Sons, New York, 1976

GETTMAN, L. R., WARD, P., and HAGAN, R. D. (1981)

A Comparison of Combined Running and Weight Training with Circuit Weight Training.

Medicine and Science in Sports and Exercise.
Vol 14: No 3, PP. 229-234, 1981

GIBSON, T. M., HARRISON, M. H. and WELLICOME, R. M. (1979)

An Evaluation of a Treadmill Work Test.

British Journal of Sports Medicine, 13, PP. 6-11, 1979

GLASSFORD, R. G. BAYCROFT, G. H. Y., SEDGEWICK, A. W., and MACNAB, R. B. J. (1969)

Comparison of Maximal Oxygen Uptake Values Determined by Predicted and Actual Methods.

Journal of Applied Physiology. 26: 509-513, 1969

GOLDMAN, R. F. (1971)

Physical Fitness, Flight Requirements and Age.

Aerospace Med. 42, P635-641 1971

GRAHAM, M.F. (1966)

Prescription for Life.

David Mckay Co., New York, 1966

GRAYBIEL, A., and WEST, H. (1945)

The Relationship Between Physical Fitness and Success in Training of U.S. Naval Flight Students.

Journal of Aviation Medicine 16, 242-249, August, 1945

HAGE, P. (1982)

Diet and Exercise Programs for Coronary Heart Disease: Better Late Than Never.

The Physician and Sportsmedicine, Vol 10: No 9, September, 1982

HALL, J. A., DIXSON, G. H., BARNARD, R. J., PRITIKIN, N. (1982)

Effects of Diet and Exercise on Vascular Disease.

The Physician and Sportsmedicine, Vol 10: No 5, May, 1982

HARRISON, G. A. (1982)

Life-styles, Well-being and Stress.

Human Biology. Vol 54: No 2, PP. 193-202, 1982

HOWARTH, C. I. (1978)

Environmental Stress. In the Uses of Psychology.

Allen and Unwin, London

HARRISON, M. H., BRUCE, D. L., BROWN, G. A. and COCHRANE, L. A. (1980)

A Comparison of Some Indirect Methods for Predicting Maximal Oxygen Uptake.

Institute of Aviation Medicine, Farnborough No 585. April, 1980

HARRISON, M. H., BROWN, G. A. and COCHRANE, L. A. (1980)

Maximal Oxygen Uptake: Its Measurement, Application and Limitations.

Institute of Aviation Medicine Farnborough, No 584, May, 1980

HARTMAN, B. O. (1967)

Psychologic Factors in Flying Fatigue.

International Psychiatric Clinics 4, 1967

HAYTHORN, W. W. (1970)

Interpersonal Stress in Isolated Groups. (Ed. J. E. McGarth)

In Social and Psychological Factors in Stress.
HOLT, Rinehart & Winston New York PP. 159-176

HEBB, D. O. (1955)

Drives and the C. N. S. (Conceptual Nervous System).

Psychological Review, 62, 243-254

HOLLOSZY, J. O. (1983)

Exercise Health and Aging: a need for more information.

Medicine and Science in Sports and Exercise. Vol 15: No 1,

PP. 1-5 1983

JACKSON, A. DISHMAN, R. K. LA CROIX, S. PATTON, R. and WEINBERG, R. (1981)

The Heart Rate, Perceived Exertion, and Pace of the 1.5 mile Run.

Medicine and Science in Sports and Exercise.
Vol 13: No 4, PP. 224-228, 1981

JOHNSGAND, K. OGILVIE, B. and MERRITT, K. (1975)

The Stress Seekers: A Psychological Study of Sports Parachutists, Racing Drivers, and Football Players.

Journal of Sports Medicine and Physical Fitness. Vol 15: PP. 158-169, 1975

JOHNSON, P. and UPDYKE, W. (1975)

Sport, Exercise and You.

Holt Rhinehart and Winston, New York, 1975

JOHNSON, W. R. (1960)

Science and Medicine of Exercise and Sports.

Harper and Brothers Publishers, New York, 1960

JOKL, E. and SIMON, E. (1964)

International Research in Sport and Physical Education.

Charles C. Thomas, Publisher, 1964

KAPPAGODA, C. T., LINDEN, R. J., and NEWELL, J. P. (1979)

Effect of the Canadian Air Force Training Programme on a Submaximal Exercise Test.

Quarterly Journal of Experimental Physiology. Vol 64: PP. 185-204, 1979

KARSON, S. (1967)

Second - Order Factors in Air Traffic Control Specialists.

Aerospace Medicine, April, 1967 PP412-414

KARSON, S. (1969)

Some Relations Between Personality Factors and Job Performance Ratings in Radar Controllers.

Aerospace Medicine, 40, PP. 823-826, 1969

KARSON, S. and O'DELL, J. W. (1971)

Performance Ratings and Personality Factors in Radar Controllers.

Journal of Clinical Psychology, 27, PP. 339-342, 1971

*

KLEIN, K.E., WEGMANN, H.M., BRUNER, H., and VOGT, L. (1969)

Physical Fitness and tolerances to environmental extremes.

Aerospace Medicine, 40, pp998-1001

KARSON, S. and O'DELL, J. W. (1974)

Personality Make-up of the American Air Traffic Controller.

Aerospace Medicine, PP. 1001-1007, September, 1974

KASCH, F. W. (1976)

The Effects of Exercise on the Ageing Process.

The Physician and Sportsmedicine, 64-68, June, 1976

KATCH, F., PECHAR G., McCARDLE, W. and WELTMAN, A. (1973)

A Relationship Between Individual Differences in a Steady Pace Endurance Run Performance and Maximal Oxygen Intake.

Research Quarterly 44, 206-215, 1973

KATCH, V. L., SADY, S. S., and FREEDSON, P. (1982)

Biological Variability in Maximum Aerobic Power.

Medicine and Science in Sports and Exercise.
Vol 14: No, 1 PP. 21-25 1982

KEREN, G., MAGAZANIK, A and EPSTEIN, Y. (1980)

Comparison of Various Methods for the Determination of VO2 Max.

Journal of Applied Physiology. 45 117-124 (1980)

KLEIN, K. E., WEGMANN, H. M. and KULINSKI, P. (1977)

Athletic Endurance Training - Advantage for Space Flight? The Significance of Physical Fitness for Selection and Training of Space Lab Crews.

Aviation Space Environmental Medicine, 48, 215-222, 1977

*

KLINZING, J. E. (1980)

The Physical Fitness Status of Police Officers.

Journal of Sports Medicine, 20, 1980 PP. 291-296

KRUG, S. E. (1979)

Development of a Formal Measurement Model for Security Screening in the Nuclear Power Plant Environment.

Institute for Personality and Ability Testing, Inc.,

KRUG, S. E. (1980)

Clinical Analysis Questionnaire Manual.

Institute For Personality and Ability Testing Inc, Champaign, ILL.

LAGER, C. (1974)

PILOT RELIABILITY.

Reliability of Human Components in Technical Systems Discussed as a Function of Workload Provocations and Individual Differences.

The Royal Institute of Technology. Stockholm 1974

LARSON, L. A. and MICHELMAN, H. (1973)

International Guide to Fitness and Health.

Crown Publishers, Inc., New York, 1973

LARSSON, L. (1982)

Physical Training Effects on Muscle Morphology in Sedentary Males at Different Ages.

Medicine and Science in Sports and Exercise. Vol 14: No 3, PP. 203-206, 1982

LASS, N. A. (1980)

Health Maintenance Exercise: Is it Safe for the Middle-Aged.

Archives Physical Medicine and Rehabilitation Vol 61: December, 1980

LAZARUS, R. S. (1966)

Psychological Stress and the Coping Process.

McGrow - Hill, New York

LEON, A. S., and BLACKBURN, H. (1977)

The Relationship of Physical Activity to Coronary Heart Disease and Life Expectancy. In: The Marathon: Physiological Medical Epidermiological and Psychological Studies, ed. MILVY2P. PP. 561-578 New York Academy of Sciences.

MACDONALD WALLACE, J. (1978)

Health Education and the Control of Stress.

Health Education Journal, 35, No3, pp199-208

MASON, M.G. (1968)

STRESS and PERFORMANCE

Carnegie Sch of P.E. Research Papers Dec 68

MEEHAN, J.P., and JACOBS, H.I. (1959)

Relation of several physiological parameters to positive G tolerance.

WADC Technical Report, pp58-665, Wright Air Development Centre, Ohio

MORRIS, J.N., HEADY, J.A., and RAFFLE, P.A.B. (1956)

Physique of London busmen.

Lancet (ii), pp569-570

LEVINE, S. and SCOTCH, N. A. (1970)

Social Stress.

Aldine Publishing Co., Chicago 1970

LITTELL, D. E., and JOY, R. J. T. (1969)

Energy cost of Pilotina Fixed - and Rotary-wing Aircraft.

J. Appl Physiol. 26, P282-285 1969

LOUHEVAARA, V. ILMARINEN, J. and OJA, P. (1980)

Comparison of the Astrand Nomogram and the Who Extrapolation Methods for Estimating Maximal Oxygen Uptake.

Scandinavian Journal of Sports Science 2(1): 21-25, 1980

MATHEWS, D. K. and FOX, E. L. (1976)

The Physiological Basis of Physical Education and Athletes. 2nd Edition

W.B. SAUNDERS Co : PHILADELPHIA.

McGARTH, J. E. (1970)

Social and Psychological Factors in Stress.

Holt, Rinehart and Winston, New York.

MICHAEL, JR., E. D. (1956)

Stress Adastion Through Exercise.

The Research Quarterly, Vol 28: No 1, 1956

MITCHELL, J. H., SPROULE, B. J., and CHAPMAN, C. B. (1958)

Physiological Meaning of the Maximal Oxygen Intake Test.

Journal of Clinical Investigation. Vol 37: PP. 538-547, 1958

MONTOYE, H. J., GAYLE, R. and HIGGINS, M. (1980)

Smoking Habits Alcohol Consumption and Maximal Oxygen Uptake.

Medicine and Science in Sports and Exercise. Vol 12: No 5, PP. 316-321, 1980

MOREHOUSE, L. E. and MILLER, A. T. (1976)

Physiology of Exercise.

The C. V. Mosby Company, 1976

PUGH,L.G.C.E.(1967)

Cold stress and muscular exercise,with special reference to accidental hypothermia.

British Medical Journal,2,pp333-337

PUGH.L.G.C.E.(1969)

Thermal, metabolic,blood and circulatory adjustments in prolonged outdoor exercise.

British Medical Journal,2,pp657-662

MOREHOUSE, L. E. and CROSS, L. (1977)

Total Fitness.

Mayflower Books, Ltd., 1977

MYLES, W. S., and CHIN, A. K. (1974)

Physical Fitness and Tolerance to Environmental Stresses: A Review of Human Research on Tolerance to and Work Capacity in Hot, Cold and High Altitude Environments.

Defence and Civil Institute of Envirnmental Medicine. Report No. 74-R-1008. Defence Research Board Canada

NAGLE, F. J. (1973)

Physiological assessment of maximal performance. In Exercise and Sports Sciences Reviews edited by J. H. Witmore.

Academic Press, PP. 313-336, 1973

PICA, J. A. and BROOKS, G. A. (1982)

Effects of Training and Age on VO2 Max in Laboratory Rats.

Medicine and Science in Sports and Exercise. Vol 14: No 3, PP. 249-252, 1982

POLLOCK, M. L., FOSTER, C., SAUSBURY, R. and SMITH, R. (1982)

Effects of a YMCA Starter Fitness Program.

The Physician and Sportsmedicine, Vol 10: No 1, January, 1982 pp 89-99

POLLOCK, M. L. (1976)

How Much Exercise is Enough?

The Physician and Sportsmedicine 6: June, 1978

READY, E. A. and QUINNEY, H. A. (1982)

Alterations in Anaerobic Threshold as the Result of Endurance Traing and Detraining.

Medicine and Science in Sports and Exercise. Vol 14: No 4, PP. 292-296, 19

RICCI, G. LAJOIE, D. PETITCLERC, R. PERONNET, F. FERGUSON, R. J. FOURNIER, M. and TAYLOR, A. W. (1982)

Left Ventricular size Following Endurance, Sprint, and Strength Training.

Medicine and Science in Sports and Exercise. Vol 14: No 5, PP. 344-347, 1982

ROWELL, L. B. (1974)

Human Cardiovascular Adjustments to Exercise and Thermal Stress.

Physiological Reviews. Vol 51: PP. 75-159, 1974

ROWELL, L. B., TAYLOR, H. L., and WANG, Y. (1964)

Limitations to Prediction of Maximal Oxygen Intake.

Physiological Reviews, Vol 19: PP. 919-927, 1964

ROBBINS, L. C., and HALL, J. H. (1970)

How to Practice Prospective Medicine.

Methodist Hospital of Indiana, Indianapolis, Indiana 1970

SCHEUER, J. and TIPTON, C. M. (1977)

Cardiovascular Adaptions to Physical Training.

Ann. Rev. Physiol. 39, PP. 221-251, 1977

SELYE, H. (1956)

The Stress of Life.

McGraw - Hill New York

SEMI-JACOBSEN, C. W. (1969)

Recordings of Inflight Stress in Jet Fighter Planes.

Aerospace Medicine 31:320 1969

SEDGWICK, A. W., BROTHERHOOD, J. R., HARRIS-DAVIDSON, A., TAPLIN, R. E., and THOMAS, D. W. (1980)

Long-term effects of Physical Training Programme On Risk Factors For Coronary Heart Disease In Otherwise Sedentary Men.

British Medical Journal, 5 July, 1980

SHARKEY, B. J. (1975)

Physiology and Physical Activity.

Harper and Row, New York, 1975

SHARKEY, B. J. (1979)

Physiology of Fitness.

Human Kinetics, Champaign, Illinois, 1979

SHARP, G. R., PATRICK, G. A., and WITHEY, W. R. (1971)

A Review of the Literature Related to the Energy Expended by Pilots Flying Various Types of Aircraft.

RAF Institute of Aviation Medicine Aircrew Equipment Group Report No 173.

SHEPHARD, R. J. (1971)

Standard Tests of Aerobic Power. In Frontiers of Fitness, edited by R. J. Shephard.

Charles C. Thomas, Publisher Springfield, Illinois 12, 233-264, 1971

SHEPHARD, R. J. (1977)

Endurance Fitness.

University of Toronto Press. 1977

SICONOLFI, S. F., CULLINANE, E. M., CARLETON, R. A., and THOMPSON, P. D. (1982)

Assessing VO2 max in Epidermiologic Studies: Modification of the Astrand-Ryhming Test.

Medicine and Science in Sports and Exercise. Vol 14: No 5, PP 335-338, 1982

SINGER, S. and HILGARD, H. R. (1978)

The Biology of People.

W. H. Freeman and Company, San Francisco, 1978

SIEGEL, W. (1977)

New Perspectives in Clinical Exercise Testing.

Sportsmedicine, 1977 PP3-12 SYMPOSIA SPECIALISTS INC.
INT. CONGRESS OF PHYSICAL ACTIVITY JUL 78

SMODLAKA, V. N. (1982)

Treadmills vs Bucycle Ergometers.

The Physician and Sportsmedicine. Vol 10: No 8, August, 1982 pp75-79

SQUIRES, R. W. and BUSKIRK, E. R. (1982)

Aerobic Capacity During Acute Exposure to Simulated Altitude, 914 to 2286 meters.

Medicine and Science in Sports and Exercise, 14, No1, pp36-40

SYMONDS, Sir C. P. (1947)

Use and abuse of the term flying stress. In Air Ministry, Psychological Disorders in Flying Personnel of the Royal Air Force Investigated During the War, 1939-1945.

H. M. S. O., LONDON.

Vol 14: No 1, PP. 36-40, 1982

TAYLOR, H. L., BUSKIRK, E. and HENSCEL, A. (1955)

Maximal Oxygen Intake as an Objective Measure of Cardio-Respiratory Performance.

Journal of Applied Physiology Vol 8: PP. 73-80, 1955

THOMPSON, J. (1977)

The Repeatability of the Measurement of Aerobic Power in Man and Factors Affecting it.

Quarterly Journal of Experimental Physiology 62, PP. 83-97, 1977

THOMPSON, J., BRICE, J. E. H., KURDY, N. M. G. and WALKER, G. H. M. (1979)

A Modified Open-Circuit Method For Estimation of Oxygen Consumption and Carbon Dioxide Excretion in Adults. Infants and Small Animals.

European Journal of Physiology, 380, PP. 197-202, 1979

VAN HUSS, W. D. (1979)

Physical Activity and Ageing. Strauss, R. H. (ed)

W. B. Saunders, Philadelphia, 1979

VANDER, A. J. (1976)

Human Physiology and the Environmental in Health and Disease.

W. H. Freeman and Company, San Franciso, 1976

VIITASALO, J. T. and VAINIKKA, M. (1982)

Effects of Five-month Conscription on Physical Fitness of 75 Recruits.

Journal of Sports Medicine. 22, 1982 pp95-101

WALLACE, J. M. (1976)

Health Education and the Control of Stress.

Health Education Journal, Vol 35: No 3, PP. 199-208, 1976

WANT, Q. L. (1959)

16 PF Test-Ground Staff Officers. RAAF

RAAF Psychology Service Technical Report. No 1/59 January, 1959

WELFORD, A. T. (1965)

What Can be Trained?

Journal of Human Movement Studies, 2, PP. 56-63, 1976

WELFORD, A. T. (1965)

Stress and Achievement.

Australian Journal of Psychology, Vol 17: No 1, 1965 pp. 1-11

WELFORD, A. T. (1966)

The Ergonomic Approach to Social Behaviour.

Ergonomic's, 9, 357-369

WELFORD, A. T. (1972)

The Future Motivation of Man.

Search, 3 113-120

WELFORD, A. T. (1973)

Stress and Performance.

Ergonomics, Vol 16: PP. 567-580, 1973

WELTMAN, A., and Stamford, B. (1983)

Psychological Effects of Exercise

The Physician and Sportsmedicine Vol II No.1 January 1983

WILMORE, J. H. (1974)

Alterations in Strength, Body Composition and Anthropometric Measurement Consequent to a 10 Week Weight Training Program.

Medicine and Science in Sports and Exercise.
Vol 6: PP. 133-138, 1974

WILMORE, J. H. (1974)

Individual Exercise Prescription.

The American Journal of Cardiology. Vol 33: 757-759, 1974

WILMORE, J. H., CONSTABLE, S. H., STANFORTH, P. R., BUONO, M. J. TSAO, Y. W., ROBY, JR., F. B., LOWDON, B. J. and RATCLIFF, R. A. (1982)

Mechanical and Physiological Calibration of Four Cycle Ergometers.

Medicine and Science in Sports and Exercise
Vol 14: No 4, PP. 322-325, 1982

YERKES, R. M. and DODSON, J. D. (1908)

The Relation of Strength of Stimulus to Rapidity of Habit Formation.

Journal of Comparative Newrology and Psychology 18, 459-482
1908

ZUCKERMAN, M. and HABER, M. M. (1965)

Need for Stimulation as a Source of Stress Response to Perceptual Isolation.

Journal of Abnormal Psychology, 70, 371-377

APPENDICES

APPENDICES

1. DURNINS % FAT SCALE
2. MODIFIED RAHE AND HOLMES STRESS QUESTIONNAIRE
3. PILOT REPORT FORM
4. CAQ QUESTIONNAIRE BOOKLET
5. CAQ INDIVIDUAL RECORD FOLDER

APPENDIX 1 Body fat and Skinfolds

The equivalent fat content, as a percentage of body-weight, for a range of values for the sum of four skinfolds (biceps, triceps, subscapular and supra-iliac) of males and females of different ages

Skin Folds(mm)	Males (age in years) 17-29	30-39	40-49	50+	Females (age in years) 16-29	30-39	40-49	50+
15	4.8	-	-	-	10.5	-	-	-
20	8.1	12.2	12.2	12.6	14.1	17.0	19.8	21.4
25	10.5	14.2	15.0	15.6	16.8	19.4	22.2	24.0
30	12.9	16.2	17.7	18.6	19.5	21.8	24.5	26.6
35	14.7	17.7	19.6	20.8	21.5	23.7	26.4	28.5
40	16.4	19.2	21.4	22.9	23.4	25.5	28.2	30.3
45	17.7	20.4	23.0	24.7	25.0	26.9	29.6	31.9
50	19.0	21.5	24.6	26.5	26.5	28.2	31.0	33.4
55	20.1	22.5	25.9	27.9	27.8	29.4	32.1	34.6
60	21.2	23.5	27.1	29.2	29.1	30.6	33.2	35.7
65	22.2	24.3	28.2	30.4	30.2	31.6	34.1	36.7
70	23.1	25.1	29.3	31.6	31.2	32.5	35.0	37.7
75	24.0	25.9	30.3	32.7	32.2	33.4	35.9	38.7
80	24.8	26.6	31.2	33.8	33.1	34.3	36.7	39.6
85	25.5	27.2	32.1	34.8	34.0	35.1	37.5	40.4
90	26.2	27.8	33.0	35.8	34.8	35.8	38.3	41.2
95	26.9	28.4	33.7	36.6	35.6	36.5	39.0	41.9
100	27.6	29.0	34.4	37.4	36.4	37.2	39.7	42.6
105	28.2	29.6	35.1	38.2	37.1	37.9	40.4	43.3
110	28.8	30.1	35.8	39.0	37.8	38.6	41.0	43.9
115	29.4	30.6	36.4	39.7	38.4	39.1	41.5	44.5
120	30.0	31.1	37.0	40.4	39.0	39.6	42.0	45.1
125	30.5	31.5	37.6	41.1	39.6	40.1	42.5	45.7
130	31.0	31.9	38.2	41.8	40.2	40.6	43.0	46.2
135	31.5	32.3	38.7	42.4	40.8	41.1	43.5	46.7
140	32.0	32.7	39.2	43.0	41.3	41.6	44.0	47.2
145	32.5	33.1	39.7	43.6	41.8	42.1	44.5	47.7
150	32.9	33.5	40.2	44.1	42.3	42.6	45.0	48.2
155	33.3	33.9	40.7	44.6	42.8	43.1	45.4	48.7
160	33.7	34.3	41.2	45.1	43.3	43.6	45.8	49.2
165	34.1	34.6	41.6	45.6	43.7	44.0	46.2	49.6
170	34.5	34.8	42.0	46.1	44.1	44.4	46.6	50.0
175	34.9	-	-	-	-	44.8	47.0	50.4
180	35.3	-	-	-	-	45.2	47.4	50.8
185	35.6	-	-	-	-	45.6	47.8	51.2
190	35.9	-	-	-	-	45.9	48.2	51.6
195	-	-	-	-	-	46.2	48.5	52.0
200	-	-	-	-	-	46.5	48.8	52.4
205	-	-	-	-	-	-	49.1	52.7
210	-	-	-	-	-	-	49.4	53.0

In two-thirds of the instances the error was within +_ 3.5% of the body-weight as fat for the women and + 5% for the men.

(After Durnin and Womersley) 1974

APPENDIX 2

STRESS RATING QUESTIONNAIRE

Many people are unaware that they are experiencing excessive stress. Here is a quick test to help you determine your level of stress. Answer the questions in terms of the last 12 months.
Check 'yes' answers in the brackets at right.

Have you lived or worked in a noisy area?.....( )3
Have you changed your living conditions or moved?.....( )3
Have you had trouble with in-laws?.....( )3
Have you taken out a large loan or motgage?.....( )3
Have you tended to fall behind with things you should do?....( )3
Have you found it difficult to concentrate at times?.....( )3
Have you frequently had trouble going to sleep?.....( )3
Have you found that you tend to eat,drink or smoke more than you really should?.....( )3
Have you watched 3 or more hours of television daily for weeks at a time?.....( )3
Have you or your spouse changed jobs or work responsibilities( )4
Has a close friend died?.....( )4
Have you been dissatisfied with your sex life?.....( )4
Have you been pregnant?.....( )4
Have you had an addition to the family?.....( )4
Have you worried about making ends meet?.....( )4
Has one of the family had bad health?.....( )4
Have you taken tranquilizers from time to time?.....( )4
Have you frequently found yourself becoming easily irritated when things don't go well?.....( )4
Have you often experienced bungled human relations-even with those you love most?.....( )4
Have you found that you're often impatient or edgy with your children or other family members?.....( )4
Have you tended to feel restless or nervous a lot of the time( )4
Have you had frequent headaches or digestive upsets?.....( )5
Have you experienced anxiety or worry for days at a time?....( )5
Have you often been so preoccupied that you have forgotten where you've put things (such as keys) or forgotten whether you've turned off appliances on leaving home or office?.....( )5
Have you been married or reconciled with your spouse?.....( )5
Have you had a serious accident, illness or surgery?.....( )5
Has anyone in your immediate family died?.....( )6
Have you divorced or separated?.....( )7

Fill in total points for "yes" ( )

* Some questions adapted from Holmes and Rahe, "Life Change RatingScale", University of Washington Medical School, 1967

APPENDIX 3

AIRCREW REPORT FORM

NAME: Fg Off KITE DATE: 2 APR 82 TIME: 1500 Hrs

ROOM TEMP: 18°C PULSE: 72 bpm TEMP: 38°C

		TIME
1.	Crew Brief	
2.	Crew in Cockpit (Engine started and FRC drills)	10 Mins

Emergency

PERCEIVED STRESS

		LOW 1	2	MOD 3	4	5	HIGH 6	7	TIME
1.	SCRAMBLE !!				X				14 Mins
2.	ENGINE – WET START/DELAY					X			16 Mins
3.	———								

		LOW 1	2	MOD 3	4	5	HIGH 6	7	TIME
3.	Take-off and climb (Major emergency)								
1.	BARRIER LAYER CONTROL/FAIL					X			18 Mins
2.	———								
3.	———								
4.	Period of approx 45 mins – practice radar intercepts (Minor)								
1.	FIRST INTERCEPT				X				25 Mins
2.	SECOND "		X						29 Mins
3.	THIRD "			X					38 Mins
5.	Recovery to base (Major emergency)								
1.	GENERATOR FAILURE				X				47 Mins
2.	UTILITY FAILURE (HYDRAULIC)						X		55 Mins
3.	———								
6.	Final approach and landing.								
1.	G.C.A.					X			67 Mins
2.	———								
3.	LANDING.						X		73 Mins

DEBRIEF AND SWITCH-OFF 90 Mins

APPENDIX 4

C A Q

FORM A
Parts I and II

T.M.

WHAT TO DO: Inside this booklet are some questions to see what interests you have and how you feel about things. There are no "right" or "wrong" answers because people have the right to their own views. All you have to do is answer what is true for *you.*

You have a separate ANSWER SHEET. Write your name and other information asked for on the answer sheet.

On the answer sheet there is a number for each question and next to the number there are three little boxes, like this: ▯ ▯ ▯. Mark your answer for each question by filling in the left-hand box if your choice is the (a) answer, fill in the middle box if your choice is the (b) answer, and fill in the right-hand box if you choose the (c) answer.

Before you start the actual test, do the examples below for practice. On your answer sheet, look at the right side where it says START HERE. Mark your choice of answers to each of the three questions now, by filling in the box for (a), (b), or (c).

EXAMPLES:

1. I like to watch team games.
   (a) yes (often) **(b) sometimes** **(c) no (never)**
2. People say I'm impatient.
   (a) true **(b) uncertain** **(c) false**
3. I prefer friends who are:
   (a) quiet **(b) in between** **(c) lively**

Ask *now* if something isn't clear.

When you are told to, start with number 1 and answer the questions. Keep these four things in mind:

1. Give only answers that are true *for you.* It is best to say what you really think.
2. You may have as much time as you need, but try to go fairly fast. It's best to give the first answer that comes to you and not spend too much time on any one question.
3. Answer *every* question one way or the other. Don't skip any.
4. You should mark the (a) or (c) answer *most* of the time. Mark the middle (b) answer *only* when you feel you have to, because neither (a) nor (c) seems to be right for you.

DO NOT TURN PAGE UNTIL TOLD TO DO SO

Catalog No. CQ 375

Part I

1. When people talk nonsense, I feel I have to put them straight.
   (a) generally, **(b) occasionally,** **(c) never.**

2. I let my feelings of jealousy influence my actions.
   (a) often, **(b) sometimes,** **(c) never.**

3. I like the feeling of working with a lot of other people.
   (a) yes, **(b) in between,** **(c) no.**

4. At times I feel like starting a lively argument or picking a fight with someone just for the sake of doing it.
   (a) true, **(b) uncertain,** **(c) false.**

5. People think of me as a solid, confident person, not upset by small failures.
   (a) yes, **(b) uncertain,** **(c) no.**

6. If being polite and calm doesn't work, I can get tough and sharp.
   (a) often, **(b) occasionally,** **(c) rarely.**

7. I don't seem to pay much attention to unimportant things, for example, remembering names of streets or stores in town.
   (a) true, I don't, **(b) uncertain,** **(c) false.**

8. I'm not interested much in newspaper debates on issues of the day.
   (a) true, **(b) uncertain,** **(c) false.**

9. In school, I preferred (or still prefer):
   (a) music, **(b) uncertain,** **(c) handiwork and crafts.**

10. I don't find it hard to speak in front of a large group.
    (a) true, I'm never bothered by it, **(b) sometimes it bothers me,** **(c) I find it very hard.**

11. I think that being free to do what I like is more important than good manners and respect for the law.
    (a) true, **(b) uncertain,** **(c) false.**

12. I enjoy going out to shows and social affairs.
    (a) often, **(b) sometimes,** **(c) very rarely.**

13. I'm uncomfortable when I'm working on something that needs quick action when others are waiting.
    (a) very much so, **(b) not much,** **(c) not at all.**

14. When the time comes to do something I have planned and looked forward to, I don't feel up to doing it.
    (a) often, **(b) sometimes,** **(c) almost never.**

15. I'd rather be:
    (a) a high school teacher, **(b) uncertain,** **(c) a forester.**

    (End of first column on answer sheet.)

16. I seem to get irritated over quite small setbacks—more than I should.
    (a) yes, often, **(b) perhaps, sometimes,** **(c) no, almost never.**

17. There are times when I do what I want and pay no attention to rules and regulations.
    (a) true, **(b) uncertain,** **(c) false.**

18. In designing something, I'd rather work:
    (a) on my own, **(b) uncertain,** **(c) with a committee.**

19. As a teenager, if I had an opinion that was different from what my parents thought, I usually:
    (a) accepted their authority, **(b) in between,** **(c) kept my own opinion.**

20. If I were called in by my boss, I'd:
    (a) be afraid I had done something wrong, **(b) in between,** **(c) make it a chance to ask for something I want.**

GO RIGHT ON TO THE NEXT PAGE

21. It is more important to bring children up with kindness than to teach them to be self-reliant or successful.
(a) yes, **(b) uncertain,** **(c) no.**

22. I prefer friends who:
(a) are efficient and practical, **(b) in between,** **(c) seriously think out their attitudes toward life.**

23. It takes a lot to make one of my family angry.
(a) true, **(b) in between,** **(c) false.**

24. For reading I enjoy:
(a) true-to-life action stories, **(b) uncertain,** **(c) light, imaginative things.**

25. I get embarrassed if I suddenly become the center of attention in a social group.
(a) yes, very much, **(b) only slightly,** **(c) no.**

26. I am a fairly strict person who always wants to see the right things done.
(a) true, **(b) in between,** **(c) false.**

27. I go to public meetings only when I have to, and stay away any other time.
(a) true, **(b) uncertain,** **(c) false.**

28. There are ways in which I honestly consider myself better than most people.
(a) yes, many, **(b) a few,** **(c) hardly any.**

29. Thunder and lightning hardly ever upset me.
(a) true, they don't, **(b) in between,** **(c) false, they *do*.**

30. If the earnings were the same, I'd rather be:
(a) a navigator or pilot, **(b) uncertain,** **(c) a lawyer.**

(End of second column on answer sheet.)

31. I hardly ever get impatient and angry with people.
(a) true, I almost never do, **(b) in between,** **(c) false, I get angry quickly.**

32. I'm able to keep my mind steadily on one job or plan as long as necessary.
(a) yes, almost always, **(b) sometimes,** **(c) no, not very often.**

33. I worry whether I'm doing the right thing when people leave me to do things on my own.
(a) often, **(b) occasionally,** **(c) rarely.**

34. The pomp and splendor of any big state ceremony are things which should be preserved.
(a) yes, **(b) uncertain,** **(c) no.**

35. If acquaintances treat me badly and show they dislike me:
(a) I tend to get downhearted, **(b) in between,** **(c) it doesn't upset me a bit.**

36. I resent aggressive people who try to get the best of someone more than I dislike people who talk a lot about their troubles.
(a) true, **(b) uncertain,** **(c) false.**

37. When I'm talking, I hardly ever walk up and down, or use my arms to express my ideas.
(a) true, **(b) in between,** **(c) false.**

38. People who brag or show they think too well of themselves annoy me.
(a) yes, generally, **(b) sometimes,** **(c) no, hardly ever.**

39. If I could get the right training, I'd rather be:
(a) a manager who improves efficiency in the company, **(b) uncertain,** **(c) a guidance counselor or worker with young people.**

40. I am active in large gatherings, for example, at a party, a dance, or a public meeting.
(a) yes, always, **(b) sometimes,** **(c) no, hardly ever.**

41. In making up my mind, I put more value on:
(a) what is right and wrong, **(b) in between,** **(c) what is practicable or workable.**

42. To be cautious and not expect too much is better than to be over-cheerful, always expecting success.
(a) true, **(b) uncertain,** **(c) false.**

43. I like to be the one who tells others what to do.
(a) yes, **(b) uncertain,** **(c) no.**

44. If plates are the least bit dirty, I feel too disgusted to eat.
(a) often, **(b) sometimes,** **(c) never.**

45. If I had an idea for a new kitchen gadget, I would prefer:
(a) working on it in the laboratory, **(b) uncertain,** **(c) selling it to people.**

(End of third column on answer sheet.)

46. If people shout suggestions when I'm playing a game, it doesn't annoy me.
(a) true, **(b) in between,** **(c) false, it does annoy me.**

47. In an argument, I:
(a) make sure what I say is right, **(b) in between,** **(c) say what I feel like saying.**

48. I like to be with a lot of people, even if I don't have much of a part in what's going on.
(a) true, **(b) uncertain,** **(c) false.**

49. When our reason tells us old customs and traditions are out of date, we should drop them.
(a) agree, **(b) uncertain,** **(c) disagree.**

50. Tormenting and troubling thoughts sometimes race through my head.
(a) true, a lot, **(b) not much,** **(c) not at all.**

51. Certain animals make me nervous.
(a) yes, often, **(b) occasionally,** **(c) no, never.**

52. A person should not delay action by going over all possible sides of a question in detail before deciding a practical matter.
(a) true, always, **(b) sometimes,** **(c) not as a rule.**

53. I'm careful of people who get more friendly and familiar than there is need for.
(a) yes, always, **(b) sometimes,** **(c) no.**

54. If I worked on a newspaper, I'd rather deal with:
(a) politics and sports, **(b) uncertain,** **(c) society news and reviewing movies.**

55. I get "stage-fright" when I come into a roomful of people.
(a) often, **(b) sometimes,** **(c) hardly ever.**

56. In my work, I:
(a) try to plan ahead, **(b) in between,** **(c) expect problems will take care of themselves when they come.**

57. I like to read about quiet, homelike things rather than battles and adventures.
(a) true, **(b) in between,** **(c) false.**

58. Threats never disturb me.
(a) true, they don't, **(b) in between,** **(c) false, they do.**

59. I seldom get so excited that I say things I'm sorry for.
(a) true, **(b) uncertain,** **(c) false, I do say things.**

GO RIGHT ON TO THE NEXT PAGE

60. It would be more interesting to be:
(a) an artist or sculptor, **(b) uncertain,** **(c) a social club secretary.**

(End of fourth column on answer sheet.)

61. People seem to get in my way and frustrate me a lot.
(a) yes, often, **(b) sometimes,** **(c) practically never.**

62. Without thinking first, I say hateful things to people I usually love.
(a) often, **(b) sometimes,** **(c) hardly ever.**

63. I like to do my own planning, without interruptions and suggestions from others.
(a) yes, **(b) in between,** **(c) no.**

64. I'd rather feel my way to a decision slowly than decide quickly by logic or reason.
(a) true, **(b) uncertain,** **(c) false.**

65. I never regret telling people frankly my feelings and ideas.
(a) true, **(b) uncertain,** **(c) false.**

66. I feel a need to go in for some heavy physical activity.
(a) often, **(b) occasionally,** **(c) never.**

67. I would enjoy being a newspaper writer on drama, concerts, opera, etc.
(a) yes, **(b) uncertain,** **(c) no.**

68. I don't get worked up or show my emotions in my voice as much as most people.
(a) true, I don't, **(b) in between,** **(c) false, I do.**

69. I have often felt that I'd like to get away and travel like a gypsy.
(a) true, **(b) perhaps,** **(c) false.**

70. I feel uncomfortable if several people watch me at work.
(a) yes, **(b) in between,** **(c) no.**

71. People think I'm too careless and casual, even when they like me.
(a) true, **(b) uncertain,** **(c) false.**

72. I'd rather dress:
(a) in something that everyone will notice, **(b) in between,** **(c) neatly and quietly.**

73. In an argument, my mind doesn't seem to work too well.
(a) true, I get confused, **(b) uncertain,** **(c) false, I am always cool.**

74. I'm not given to big "ups" and "downs" of mood.
(a) true, I'm not, **(b) in between,** **(c) false, I am.**

75. For special holidays and birthdays, I:
(a) like to give personal presents, **(b) uncertain,** **(c) feel that buying presents is a bit of a nuisance.**

(End of fifth column on answer sheet.)

76. The noise of a nail on glass, and other screechy sounds, set my nerves on edge.
(a) unbearably, **(b) somewhat,** **(c) hardly at all.**

77. When I talk, I like:
(a) to say things just as they come to me, **(b) in between,** **(c) to get my thoughts carefully organized first.**

78. If members of my family disagree with neighbors and show we feel independent, I don't worry.
(a) true, **(b) in between,** **(c) false.**

79. Logic and reason are usually enough to get people to change their ideas.
(a) true, **(b) uncertain,** **(c) false.**

80. I get depressed if I think too much about my serious responsibilities.
(a) often, **(b) sometimes,** **(c) rarely.**

81. I like having animals—cats, dogs, horses, etc.—around me.
(a) true, **(b) uncertain,** **(c) false.**

82. Members of my family quickly show their irritation over small things.
(a) yes, a lot, **(b) not much,** **(c) hardly ever.**

83. I never get bored or annoyed with poorly educated people.
(a) true, **(b) in between,** **(c) false.**

84. I get excited about plays and novels.
(a) yes, **(b) in between,** **(c) no.**

85. I consider myself a very sociable, outgoing person.
(a) yes, **(b) in between,** **(c) no.**

86. If people are clever enough to get around rules without seeming to break them, they should:
(a) certainly do so, **(b) do so if there's a special reason,** **(c) not do it, anyway.**

87. I like an evening:
(a) at a lively party, **(b) in between,** **(c) with a quiet hobby.**

88. If I were to disagree with my boss, I'd probably:
(a) keep it to myself, **(b) uncertain,** **(c) come out and say so.**

89. In a dark house, I can sometimes hardly control my fears.
(a) true, **(b) in between,** **(c) false.**

90. If someone asked me to work for a charity drive, I would:
(a) generally accept, **(b) occasionally accept,** **(c) say I'm too busy.**

(End of sixth column on answer sheet.)

91. I can put worries and responsibilities out of my mind whenever I want to.
(a) yes, **(b) uncertain,** **(c) no.**

92. I believe in doing the right thing socially, and it is second nature to me to ask how my actions look to others.
(a) true, **(b) in between,** **(c) false.**

93. I don't like people to say I'm different or peculiar.
(a) true, I don't, **(b) uncertain,** **(c) false.**

94. Most people will fool themselves and give silly reasons in order to keep comfortable privileges or gain a profit.
(a) true, **(b) perhaps,** **(c) false.**

95. I rarely lie awake because of unhappy, disturbing ideas.
(a) true, **(b) in between,** **(c) false, I do lie awake.**

96. I am almost never bothered by tense muscles and vague heart pains in my chest.
(a) true, **(b) uncertain,** **(c) false, I *do* get tense pains.**

97. I like vivid, true-to-life love scenes in a movie.
(a) true, **(b) uncertain,** **(c) false.**

98. Most people would try to get away with as much as they could if they weren't afraid of being caught:
(a) true, **(b) perhaps,** **(c) false.**

GO RIGHT ON TO THE NEXT PAGE

99. In school, I preferred (or still prefer):
(a) arithmetic or mathematics, **(b) uncertain,** **(c) literature or English.**

100. In a small group, I'm satisfied to sit back and let others do most of the talking.
(a) yes, **(b) in between,** **(c) no.**

101. When I was in school, I didn't get in trouble with teachers because of bad behavior.
(a) true, I almost never got into trouble, **(b) in between,** **(c) false, I got into plenty of trouble.**

102. I'd rather spend time fishing or gardening than watching exciting horse or car races.
(a) true, **(b) uncertain,** **(c) false.**

103. When I have to tell people I disagree with them, I stay calm and I'm not nervous.
(a) true, **(b) in between,** **(c) false.**

104. If I meet drunken people, I:
(a) stay cool and relaxed, **(b) am slightly nervous,** **(c) get very nervous and embarrassed.**

105. I have never done daring things just for fun.
(a) true, I never have, **(b) in between,** **(c) false, I have.**

(End of seventh column on answer sheet.)

106. When something really makes me furious, I find I calm down again quite quickly.
(a) yes, **(b) in between,** **(c) no.**

107. I have trained myself so I can be very patient with people.
(a) yes, always, **(b) sometimes,** **(c) no, not often.**

108. I would rather enjoy life quietly in my own "way" than be admired for my achievements.
(a) true, **(b) uncertain,** **(c) false.**

109. To get an interesting argument going, I believe in gently telling people what's wrong with their ideas.
(a) generally, **(b) occasionally,** **(c) never.**

110. If I know that an operation is being done on an animal (for a good reason), it does not upset me.
(a) true, I treat it as a common-sense matter, **(b) uncertain,** **(c) false, it gives me the horrors.**

111. I value good manners and social "know-how" in people more than some traits other people think "worthy."
(a) yes, **(b) uncertain,** **(c) no.**

112. I don't enjoy long discussions with people who have ideas about serious, intellectual things.
(a) true, I don't enjoy them, **(b) uncertain,** **(c) false, I *do* enjoy them.**

113. If I make a silly mistake in company I soon forget it.
(a) yes, easily, **(b) sometimes,** **(c) no, I cannot.**

114. I am more sensitive to art and my surroundings than most people.
(a) true, **(b) uncertain,** **(c) false.**

115. I like to join clubs and social groups.
(a) true, **(b) uncertain,** **(c) false.**

116. Banks should not be careless. If they made a mistake and didn't charge me for something:
(a) it wouldn't be my business to tell them, **(b) uncertain,** **(c) I'd feel I had to point it out and pay.**

117. I like a job with variety, even if it has a bit of risk.
(a) yes, **(b) uncertain,** **(c) no.**

GO RIGHT ON TO THE NEXT PAGE

118. Being waited on by a servant or someone like that:
(a) embarrasses me, **(b) in between,** **(c) makes me feel fine.**

119. I have very emotional dreams that leave me disturbed when I wake up.
(a) often, **(b) sometimes,** **(c) almost never.**

120. I would like to be a lion tamer in a circus.
(a) yes, **(b) perhaps,** **(c) no.**

(End of eighth column on answer sheet.)

These last few questions are the kind that **do** have right answers. See how well you can do with them. Mark the one you think is the correct one.

121. "Spade" is to "dig" as "knife" is to:
(a) cut, **(b) sharp,** **(c) point.**

122. Which one of the following things is of a different sort from the others?
(a) candle, **(b) electric light,** **(c) moon.**

123. Which one of the following fractions is not the same kind as the others?
(a) 3/7, **(b) 3/9,** **(c) 3/11.**

124. Which one of the following words does not belong with the others?
(a) play, **(b) ask,** **(c) say.**

125. "Big" means the same as:
(a) fat, **(b) tall,** **(c) large.**

126. Which one of the following should come next at the end of this row of letters: xoooooxxoooxxx?
(a) oxxx, **(b) xooo,** **(c) ooxx.**

127. "Size" is to "length" as "dishonest" is to:
(a) prison, **(b) stealing,** **(c) sin.**

128. Which one of the following words does not belong with the others?
(a) zigzag, **(b) wide,** **(c) straight.**

(End of Part I)

STOP HERE. MAKE SURE YOU HAVE ANSWERED EVERY QUESTION.

Part II

A Note About Answering Part II.

Do the same for Part II as you did for Part I. There are no right or wrong answers to these questions, but only what seem the right answers for *you*. There are three possible answers for each question. On the separate answer sheet, fill in one of the three boxes—(a), (b), or (c). You should not use the middle answer, (b), very often. Some questions may not have the words just the way you want them but *mark every one* the best you can.

1. My mind works quickly and well these days.
   (a) yes, nearly always, **(b) sometimes,** **(c) hardly ever.**

2. I feel fit and happy.
   (a) most of the time, **(b) sometimes,** **(c) very rarely.**

3. I never feel so bored and disgusted that I'd like to smash the whole sorry place.
   (a) true, I never do, **(b) uncertain,** **(c) false, I often do.**

4. I get restless and depressed if I don't get some excitement.
   (a) often, **(b) sometimes,** **(c) never.**

5. Noise wakens me even from deep sleep.
   (a) yes, often, **(b) sometimes,** **(c) no, hardly ever.**

6. I seem to be clumsy and shaky in handling things.
   (a) always, **(b) sometimes,** **(c) rarely.**

7. My zest for work is high.
   (a) nearly always, **(b) sometimes,** **(c) hardly ever.**

8. I feel lonely and miserable.
   (a) yes, all the time, **(b) sometimes,** **(c) no, hardly ever.**

9. I'm not troubled by feelings of guilt.
   (a) true, I'm not troubled, **(b) uncertain,** **(c) false, I am troubled.**

10. I tell people how pointless or stupid I think common beliefs are and I don't care what they think of me.
    (a) yes, **(b) in between,** **(c) no.**

11. I know pretty well what worthwhile things I want to do in life.
    (a) true, **(b) in between,** **(c) false.**

12. I've sometimes actually felt that someone may be trying to poison me.
    (a) true, **(b) uncertain,** **(c) false.**

13. I get downhearted and can't snap out of it.
    (a) often, **(b) sometimes,** **(c) practically never.**

14. I don't mind if people joke about me and say I'm "quite a character."
    (a) true, I don't mind, **(b) uncertain,** **(c) false, I *do* mind.**

15. At times I find I have to speak very slowly, as if I had to wait for the words to come to me.
    (a) true, **(b) uncertain,** **(c) false.**

16. I don't often feel I have to check and recheck, to make sure I've done small jobs right.
    (a) true, I don't have to check, **(b) in between,** **(c) false, I *do* have to check.**

17. Some simple, unimportant idea or words run through my mind on and off for days.
    (a) often, **(b) once in a while,** **(c) very rarely.**

18. My emotions are so unreasonable that I don't feel fit to look after myself.
    (a) often, **(b) sometimes,** **(c) I never feel like this.**

(End of first column on answer sheet.)

19. Sometimes I feel that my nerves are going to pieces.
(a) true, **(b) uncertain,** **(c) false.**

20. I can't keep up with daily activities because I don't feel well.
(a) most of the time, **(b) sometimes,** **(c) rarely.**

21. There are still lots of interesting things in life that I really look forward to.
(a) true, **(b) uncertain,** **(c) false.**

22. I get no thrill in seeing a daring person take risks that people say are foolish, and yet get away with them.
(a) true, I get no thrill, **(b) occasionally,** **(c) false, I like it.**

23. I would like adventurous jobs like auto-racing or flying.
(a) yes, very much, **(b) not much,** **(c) no, not at all.**

24. I hate the thought of having to go to the hospital if I got sick.
(a) yes, **(b) not much,** **(c) no, that doesn't bother me.**

25. I hardly ever feel sad and gloomy.
(a) true, I hardly ever feel sad and gloomy, **(b) sometimes I do,** **(c) false, I'm often very gloomy.**

26. When I wake up in the morning I just don't have enough energy to start the day.
(a) true, **(b) perhaps,** **(c) false.**

27. I have fears that no one really loves me.
(a) often, **(b) once in a while,** **(c) not at all.**

28. I feel too depressed and "useless" to want to talk to people.
(a) true, **(b) in between,** **(c) false.**

29. I have a weak stomach, and I easily get constipated.
(a) true, **(b) in between,** **(c) false.**

30. Personally, I don't feel people have treated me unfairly.
(a) true, I don't feel unfairly treated, **(b) uncertain,** **(c) false, I *do* feel that people have been quite unfair to me.**

31. I never feel so active, as some people say they do, that I can go without sleep for two or three days at a time.
(a) true, I never feel this way, **(b) uncertain,** **(c) false, I have felt like that.**

32. Criticism easily hurts my feelings and makes me give up.
(a) often, **(b) sometimes,** **(c) never.**

33. I get so fed up with people bothering me that I just don't care whether I answer or not.
(a) often, **(b) sometimes,** **(c) almost never.**

34. I don't believe that the sight of certain things like a black cat brings me bad luck.
(a) true, I don't believe that. **(b) uncertain,** **(c) false, I *do* believe that.**

35. When I'm in a place of worship or some place where silence or prayer is expected, I'm afraid I may feel like shouting out.
(a) often, **(b) sometimes,** **(c) never.**

36. I can almost always see the "funny side of life" and get enjoyment from the things I do.
(a) true, **(b) in between,** **(c) false.**

(End of second column on answer sheet.)

GO RIGHT ON TO THE NEXT PAGE

37. Every few days my stomach feels bloated and uncomfortable.
(a) yes, definitely, **(b) a little,** **(c) no, not at all.**

38. I feel weak and ill.
(a) most of the time, **(b) sometimes,** **(c) practically never.**

39. For me there doesn't seem to be much in life that's really worth doing.
(a) true, there's little worth living for, **(b) in between,** **(c) false, I enjoy life.**

40. I'm more likely to complain about how unfair things are rather than to think "well, that's the way it goes," or "that's life."
(a) yes, things are unfair, **(b) uncertain,** **(c) no.**

41. In school, I avoided jobs where I had to speak up and take charge of new projects.
(a) yes, generally, **(b) somewhat,** **(c) no, not at all.**

42. If I'm upset, my muscles twitch and jump.
(a) yes, often, **(b) occasionally,** **(c) no.**

43. I very seldom have moments when my life seems lonely and empty.
(a) true, **(b) uncertain,** **(c) false.**

44. A dark mood of depression, coming on for no reason, is something I hardly ever have.
(a) true, I don't have such moods, **(b) uncertain,** **(c) false, I *do* have moods like this.**

45. I almost never get so tense and "worked up" that my hands shake.
(a) true, I don't get this way, **(b) uncertain,** **(c) false, I do get like this.**

46. I feel life is so pointless and silly that I no longer even try to tell people how I feel.
(a) true, **(b) in between,** **(c) false.**

47. I find it easy to keep up cheerful "small talk" with people.
(a) always, **(b) sometimes,** **(c) never.**

48. Too many people are making laws to interfere with what I consider my freedom.
(a) true, **(b) uncertain,** **(c) false.**

49. I'm most happy when I go my own way, paying no attention to what people say.
(a) yes, **(b) uncertain,** **(c) no.**

50. I get a certain pleasure from facing emergencies and quarrels that seem to upset others.
(a) often, **(b) sometimes,** **(c) never.**

51. Members of my family and people who I thought liked me have sometimes been awfully mean and hostile.
(a) true, **(b) uncertain,** **(c) false.**

52. I keep worrying even about unimportant things if they don't seem quite right.
(a) often, **(b) sometimes,** **(c) never.**

53. I'm not bothered by thoughts that I might accidentally bring harm to members of my family.
(a) true, I'm not bothered, **(b) uncertain,** **(c) false, it does worry me.**

54. I have plenty of good qualities and talents that people usually appreciate and recognize.
(a) yes, **(b) in between,** **(c) no, I have very few.**

(End of third column on answer sheet)

GO RIGHT ON TO THE NEXT PAGE

55. I hardly ever feel unwell and "out of sorts."
(a) true, I hardly ever feel out of sorts, **(b) in between,** **(c) false, I often feel that way.**

56. I feel my health is run down and I should see a doctor soon.
(a) true, **(b) uncertain,** **(c) false.**

57. I'm not "fed up" and disgusted with myself and everything around me.
(a) true, I'm not, **(b) in between,** **(c) false, I am fed up.**

58. I worry and think a lot about things that may go wrong.
(a) often, **(b) sometimes,** **(c) almost never.**

59. I feel discontented unless I can find some daring thing to do.
(a) yes, **(b) uncertain,** **(c) no.**

60. My head stays clear and calm in an emergency.
(a) always, **(b) sometimes,** **(c) never.**

61. I hardly ever feel under such strain that it's too much effort to cope with things.
(a) true, I don't feel under a strain, **(b) uncertain,** **(c) false, I *do* lack energy to cope.**

62. I need more sleep and almost always wake up tired.
(a) true, **(b) in between,** **(c) false.**

63. I don't get dizzy spells and heart flutters if I'm suddenly asked to do something.
(a) true, I don't feel like this, **(b) uncertain,** **(c) false, I do get dizzy spells and heart flutters.**

64. My life has lots of enjoyment and excitement in it.
(a) almost all the time, **(b) sometimes,** **(c) almost never.**

65. I find it easy to be relaxed, friendly, and cheerful with other people's young children.
(a) almost always, **(b) sometimes,** **(c) hardly ever.**

66. When I've done something well, I have met more friendly encouragement than jealousy or envy.
(a) true, **(b) in between,** **(c) false.**

67. People gossip about some of the daring things I do, but I don't mind being the center of their attention.
(a) true, **(b) once in a while,** **(c) false.**

68. I don't have very many fears of hidden physical dangers.
(a) true, **(b) partly true,** **(c) false, I am fearful.**

69. Most people are kind and ready to help you.
(a) true, **(b) uncertain,** **(c) false.**

70. I have a habit of counting things, such as my steps, or bricks in a wall, for no reason.
(a) true, I do this most of the time, **(b) sometimes,** **(c) false, I very rarely do this.**

71. There are things in my daily life that I feel I have to do *exactly* right no matter how much time or trouble this fussiness demands.
(a) I feel like that about many things, **(b) only one or two things,** **(c) none.**

72. I'm the kind of person people seem to respect and depend on for good advice.
(a) yes, **(b) uncertain,** **(c) no.**

(End of fourth column on answer sheet.)

GO RIGHT ON TO THE NEXT PAGE

73. Much of the time I feel sluggish and too weary to move.
(a) true, **(b) partly true,** **(c) false.**

74. I almost never feel sick and disgusted with my life.
(a) true, I almost never feel like that, **(b) in between,** **(c) false, I often feel like that.**

75. I think about death, which ends all our problems.
(a) a lot, **(b) sometimes,** **(c) hardly ever.**

76. I like to be with a group that livens things up with practical jokes, even when they are a bit risky.
(a) yes, certainly, **(b) perhaps,** **(c) no.**

77. I seldom speak right out and say what I think, good or bad, about people's actions.
(a) true, I seldom do this, **(b) uncertain,** **(c) false, I speak out.**

78. I like the responsibility of handling family money and business affairs.
(a) yes, **(b) uncertain,** **(c) no.**

79. I get into moods when I feel low and depressed.
(a) often, **(b) occasionally,** **(c) hardly ever.**

80. Sometimes I can't sleep for thinking of all the things I should have done.
(a) true, I can't sleep because of this, **(b) in between,** **(c) false, I can sleep no matter what is left undone.**

81. I hardly ever feel that I've failed in my duties.
(a) true, I don't, **(b) in between,** **(c) false, I *am* troubled by guilt feelings.**

82. If people tell me I'm neglectful or not doing my part, I don't really care.
(a) true, I don't care, **(b) uncertain,** **(c) false, I do care.**

83. I don't get mad about rules and regulations and break them just to show my rights.
(a) true, I very rarely get mad, **(b) uncertain,** **(c) false, I often get mad.**

84. I can trust most of the people who say they are my friends.
(a) yes, completely, **(b) perhaps,** **(c) no, not at all.**

85. I'm nervous about getting hurt when I'm in a crowd or mob.
(a) often, **(b) sometimes,** **(c) almost never.**

86. At times strange, sudden feelings—like wanting to smash a mirror or shout in a quiet place—seem to take hold of me.
(a) true, often, **(b) only occasionally,** **(c) no, never.**

87. I never have moments when I forget what town I'm in, and what the names of my friends are.
(a) true, I don't forget, **(b) in between,** **(c) false, I do forget.**

88. I don't usually feel a bit lost or anxious when I'm away from home where things are done differently.
(a) true, I don't usually, **(b) uncertain,** **(c) false, I often do.**

89. There are times when I think I'm no good for anything at all.
(a) true, many, **(b) in between,** **(c) false, almost never.**

90. I make up my mind easily and quickly, and seldom have reason to change it.
(a) true, **(b) in between,** **(c) false.**

(End of fifth column on answer sheet.)

91. I almost never feel that life is a burden.
(a) true, **(b) in between,** **(c) false.**

92. Lately I don't "give a darn" what happens to me.
(a) true, all the time, **(b) sometimes,** **(c) false, I don't feel like that.**

93. Life for me has become empty and meaningless.
(a) quite true, **(b) partly true,** **(c) false.**

94. Everyday life doesn't give me much chance to express myself, and I need something exciting.
(a) true, I feel frustrated, **(b) uncertain,** **(c) false, I have plenty of expression.**

95. I am confident that I can face and handle most emergencies that come up.
(a) true, always, **(b) sometimes,** **(c) false, I cannot face emergencies.**

96. I get a feeling of tension and have a ringing and buzzing in my ears.
(a) yes, often, **(b) sometimes,** **(c) no, almost never.**

97. I feel worn out and can't get enough rest.
(a) usually, **(b) sometimes,** **(c) very seldom.**

98. I rarely lie awake at night wondering what will happen because of wrong things that I've done.
(a) true, **(b) in between,** **(c) false, I do lie awake.**

99. I seem to blame myself for everything that goes wrong, and I'm always critical of myself.
(a) true, most times, **(b) true, sometimes,** **(c) false.**

100. I'm happiest alone, away from people.
(a) true, **(b) in between,** **(c) false.**

101. People choose their "friends" more for what those people can do for them and not for real friendship.
(a) yes, generally, **(b) perhaps, occasionally,** **(c) no, not at all.**

102. There is no real danger in most small towns of being beaten up when you go for a walk.
(a) true, **(b) uncertain,** **(c) false.**

103. When people strongly disagree with me, I feel excited and challenged, and I enjoy it.
(a) very much so, **(b) slightly,** **(c) not really.**

104. People don't push me much to do things I don't want to do.
(a) true, they don't, **(b) uncertain,** **(c) false, they often do.**

105. People seem to be ganged up to treat me as if my opinions didn't matter.
(a) often, **(b) sometimes,** **(c) never.**

106. People never say that I'm much too orderly, neat, and clean.
(a) true, they don't say that, **(b) uncertain,** **(c) false, people think I am that way.**

107. There are only a few friends that I can trust and depend on, or who seem to trust and depend on me.
(a) true, hardly any, **(b) some,** **(c) false, I trust most.**

108. I sometimes think that I am somehow a doomed or condemned person.
(a) true, **(b) perhaps,** **(c) false.**

(End of sixth column on answer sheet.)

109. I don't often have trouble in swallowing my food.
(a) true, **(b) in between,** **(c) false, I can sometimes scarcely eat.**

110. I almost never wish I were "out of it all."
(a) true, I almost never wish that, **(b) uncertain,** **(c) false, I *do* wish that.**

111. I don't enjoy doing *anything* any more.
(a) true, **(b) in between,** **(c) false.**

112. Other people seem to get less upset by dangers and troubles than I do.
(a) true, others get less upset, **(b) uncertain,** **(c) false, others get more upset.**

113. When I hear of people who have said bad things about me, I like to meet them face to face.
(a) true, **(b) uncertain,** **(c) false.**

114. I dream a lot about frightening events.
(a) yes, often, **(b) sometimes,** **(c) no.**

115. I sleep soundly and wake up full of energy.
(a) true, generally, **(b) only sometimes,** **(c) never, nowadays.**

116. I have feelings I have done something horribly wrong but don't know what.
(a) often, **(b) sometimes,** **(c) never.**

117. I'm very bothered when I think of the bad things I have done in my life.
(a) true, **(b) sometimes,** **(c) I don't get bothered at all.**

118. I enjoy making the effort to go and meet new people.
(a) yes, **(b) in between,** **(c) no.**

119. When people I know get public praise for their work it makes me feel I must be no good.
(a) true, **(b) uncertain,** **(c) false.**

120. Most lawyers can be trusted not to swindle you by charging too much.
(a) true, **(b) perhaps,** **(c) false.**

121. I don't think I can stand pain and discomfort as well as most people.
(a) true, **(b) uncertain,** **(c) false.**

122. I have the feeling that most people who know me really and truly like me.
(a) true, **(b) in between,** **(c) false.**

123. In dark corners I often think I see people watching me, but when I look carefully they disappear.
(a) true, often, **(b) occasionally,** **(c) false, I never do.**

124. Dirty words and embarrassing ideas run through my mind, and I can't get rid of them.
(a) often, **(b) sometimes,** **(c) almost never.**

125. I lose my head when I get excited and I do foolish things.
(a) often, **(b) once in a while,** **(c) rarely.**

126. I consider myself as able to manage my affairs as most people I know.
(a) yes, **(b) perhaps,** **(c) no.**

(End of seventh column on answer sheet.)

127. I don't feel I'm any worse or have more bad health than anybody else.
(a) true, I don't feel this way, **(b) uncertain,** **(c) false.**

128. I feel that I'm at the "end of my rope" and don't want to go on any more.
(a) often, **(b) sometimes,** **(c) almost never.**

129. When I get up in the morning, I feel I'm ready to face the day's problems.
(a) almost always, **(b) sometimes,** **(c) hardly ever.**

130. I often feel bored and in a rut so I like to keep trying new things.
(a) yes, **(b) uncertain,** **(c) no.**

131. Mice and snakes don't give me shivers.
(a) true, they don't, **(b) uncertain,** **(c) false, they *do* give me the shivers.**

132. I feel self-confident and relaxed.
(a) almost all the time, **(b) sometimes,** **(c) hardly ever.**

133. I worry because I don't do much about solving my problems.
(a) I often worry, **(b) sometimes,** **(c) I almost never worry about it.**

134. I have dreams more like nightmares in which I am deserted and alone.
(a) often, **(b) sometimes,** **(c) almost never.**

135. Stomach trouble is something I don't have very often.
(a) true, **(b) uncertain,** **(c) false, I *do* have it.**

136. I find it easy to chat and joke with a person of the opposite sex.
(a) true, **(b) in between,** **(c) false.**

137. Many people do their best, when they're talking to you, to dig into private business and personal affairs.
(a) generally, **(b) sometimes,** **(c) hardly ever.**

138. A safe rule in life is "Trust nobody."
(a) yes, always, **(b) sometimes,** **(c) no, hardly ever.**

139. People who don't have enough "guts" to look after themselves should be looked after, free, by others.
(a) yes, true, **(b) uncertain,** **(c) no, false.**

140. I think I get all the sympathy and understanding that a person should expect.
(a) yes, **(b) uncertain,** **(c) no.**

141. I've never felt that someone was trying to get me to do something by some kind of hypnotism or evil influence.
(a) true, I've never felt like that, **(b) uncertain,** **(c) false, I have felt like that.**

142. I have never felt an urge to do disorderly and violent things.
(a) true, I haven't, **(b) sometimes I have,** **(c) false, I often have.**

143. I rate myself as a happy, contented person in spite of troubles here and there.
(a) true, **(b) uncertain,** **(c) false.**

144. I sometimes doubt whether I have been of much use to anyone in my life.
(a) true, **(b) uncertain,** **(c) false.**

STOP HERE. MAKE SURE YOU HAVE ANSWERED EVERY QUESTION.

APPENDIX 5

CAQ INDIVIDUAL RECORD FOLDER

CONFIDENTIAL

me: _____

k: _____ Age: _____ Date Tested: _____

rms Used: _____

Name

Instructions

ollow the directions for obtaining the CAQ Validity (V) score given on page 2 of this folder from the item sponses on Part I of the CAQ.

ansfer the raw scores from Part I of the answer sheet to page 2 of this folder. **Be especially careful to watch that e Factor B score, which is given last on the answer sheet, is recorded in the correct spot on page 2 (i.e., as the cond of the normal primaries).** Transfer the raw scores from Part II of the answer sheet to page 3 of this folder.

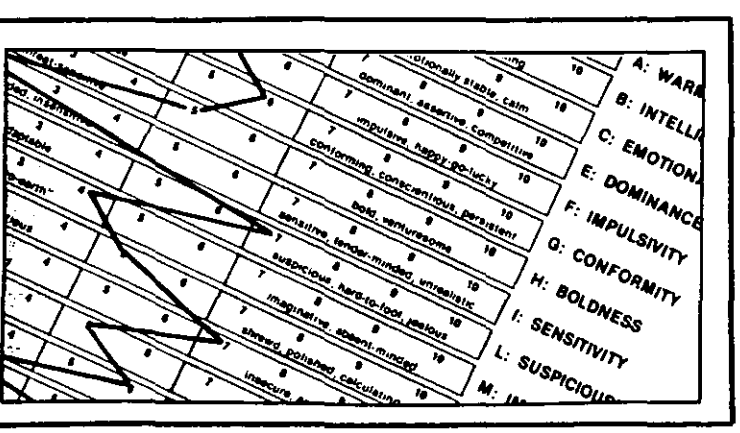
onvert the raw scores on each of the 28 primary factors to sten scores by using one of the norm tables given in e CAQ Manual.

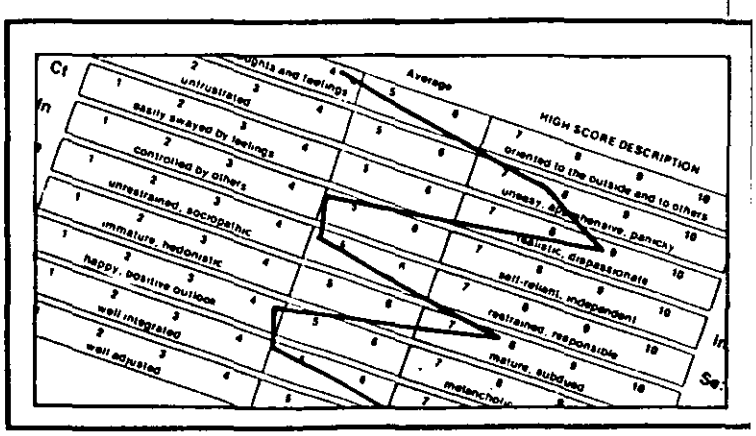
econd-order scores can be obtained either by using the equations given in the Manual or by using a simplified and procedure presented on pages 5 (for females) and 6 (for males). If this second method is selected, follow e five steps listed below:

1) In the column at the far left of the form, place the sten score for each factor in the appropriate box.
2) Follow the dotted line from Factor A sten score until a circled number is reached. Multiply the Factor A sten score by the circled number. Enter the result in the box immediately following the circled number. Continue following the line until another circled number is encountered. Repeat the same procedure as before. Continue until all boxes in the Factor A row are filled.
3) Repeat the procedure in Step 2 for Factor B and all other factors.
4) Add each vertical column on the page and place the sum of each column in the appropriate box below.
5) In each pair of vertical columns the sum of the second column (the shaded column) is subtracted from the sum of the first column. Place the answer in the box beneath the subtraction. The decimal point for the score has already been correctly placed on the form. The scores obtained from this procedure are the sten scores of the second-order factors indicated. (Note that the second-order scores calculated here may differ slightly from those calculated by means of the equations given in the Manual because the weights and constants here have been rounded to one place for simplicity.)

hen the calculations are completed, the second-order scores may be transferred to page 3 of this folder.

nally, the results may be profiled to give a graphic portrayal of the test data as shown below.





1. VALIDITY CHECK

1. Turn the answer sheet to Side 1.
2. If the answer to each of the following items is marked as indicated, put a check in the box to the right.

Item	Keyed Alternative	
4	b	☐
18	b	☐
24	b	☐
39	b	☐
67	b	☐
75	b	☐
81	b	☐
90	c	☐
110	c	☐
120	a	☐

3. Add the number of check marks and enter the total in the box to the right. V ☐

Scores of 3 or higher on this scale are relatively rare and suggest that the rest of the profile should be interpreted cautiously. Details regarding the development and interpretation of V scores are given on pages 7 and 10 of the CAQ *Manual.*

2. NORMAL PERSONALITY TRAITS

	LOW SCORE DESCRIPTION	Average	HIGH SCORE DESCRIPTION		raw	sten
A	1 2 3 4 reserved, detached, aloof	5 6	7 8 9 10 warm, personable, easygoing	A: WARMTH		
B	1 2 3 4 concrete-thinking	5 6	7 8 9 10 abstract-thinking	B: INTELLIGENCE		
C	1 2 3 4 easily upset, emotional	5 6	7 8 9 10 emotionally stable, calm	C: EMOTIONAL STABILITY		
E	1 2 3 4 submissive, accommodating	5 6	7 8 9 10 dominant, assertive, competitive	E: DOMINANCE		
F	1 2 3 4 prudent, sober, serious	5 6	7 8 9 10 impulsive, happy-go-lucky	F: IMPULSIVITY		
G	1 2 3 4 expedient, disregards rules	5 6	7 8 9 10 conforming, conscientious, persistent	G: CONFORMITY		
H	1 2 3 4 shy, timid, threat-sensitive	5 6	7 8 9 10 bold, venturesome	H: BOLDNESS		
I	1 2 3 4 tough-minded, insensitive	5 6	7 8 9 10 sensitive, tender-minded, unrealistic	I: SENSITIVITY		
L	1 2 3 4 trusting, adaptable	5 6	7 8 9 10 suspicious, hard-to-fool, jealous	L: SUSPICIOUSNESS		
M	1 2 3 4 practical, "down-to-earth"	5 6	7 8 9 10 imaginative, absent-minded	M: IMAGINATION		
N	1 2 3 4 forthright, unpretentious	5 6	7 8 9 10 shrewd, polished, calculating	N: SHREWDNESS		
O	1 2 3 4 confident, self-satisfied	5 6	7 8 9 10 insecure, apprehensive	O: INSECURITY		
Q_1	1 2 3 4 conservative, traditional	5 6	7 8 9 10 experimenting, innovative	Q_1: RADICALISM		
Q_2	1 2 3 4 group-adherent, sociable	5 6	7 8 9 10 self-sufficient, resourceful	Q_2: SELF-SUFFICIENCY		
Q_3	1 2 3 4 undisciplined, uncontrolled	5 6	7 8 9 10 self-disciplined, controlled, precise	Q_3: SELF-DISCIPLINE		
Q_4	1 2 3 4 relaxed	5 6	7 8 9 10 tense, frustrated, driven	Q_4: TENSION		

3. THE CLINICAL FACTORS

LOW SCORE DESCRIPTION	Average	HIGH SCORE DESCRIPTION		raw	sten
1 2 3 4 few somatic complaints	5 6	7 8 9 10 obsessed by ill health	D_1: HYPOCHONDRIASIS		
1 2 3 4 contented	5 6	7 8 9 10 despondent, thinks of self-destruction	D_2: SUICIDAL DEPRESSION		
1 2 3 4 restrained	5 6	7 8 9 10 craves excitement, hypomanic	D_3: AGITATION		
1 2 3 4 composed	5 6	7 8 9 10 shaky, frightened, clumsy	D_4: ANXIOUS DEPRESSION		
1 2 3 4 energetic	5 6	7 8 9 10 gloomy, wornout, sad	D_5: LOW ENERGY DEPRESSION		
1 2 3 4 untroubled	5 6	7 8 9 10 guilty, self-critical, resentful	D_6: GUILT & RESENTMENT		
1 2 3 4 seeks relationships with others	5 6	7 8 9 10 seclusive, feels useless	D_7: BOREDOM & WITHDRAWAL		
1 2 3 4 reasonable	5 6	7 8 9 10 unreasonable, feels persecuted	Pa: PARANOIA		
1 2 3 4 inhibited	5 6	7 8 9 10 uninhibited, unsocialized	Pp: PSYCHOPATHIC DEVIATION		
1 2 3 4 reality-oriented	5 6	7 8 9 10 retreats from reality, withdrawn	Sc: SCHIZOPHRENIA		
1 2 3 4 noncompulsive	5 6	7 8 9 10 obsessive, compulsive	As: PSYCHASTHENIA		
1 2 3 4 feels competent, has sense of self-worth	5 6	7 8 9 10 feels inferior and unworthy	Ps: PSYCHOLOGICAL INADEQUACY		

4. SECOND-ORDER FACTORS

LOW SCORE DESCRIPTION	Average	HIGH SCORE DESCRIPTION		sten
1 2 3 4 oriented to inner thoughts and feelings	5 6	7 8 9 10 oriented to the outside and to others	Ex: EXTRAVERSION	
1 2 3 4 unfrustrated	5 6	7 8 9 10 uneasy, apprehensive, panicky	Ax: ANXIETY	
1 2 3 4 easily swayed by feelings	5 6	7 8 9 10 realistic, dispassionate	Ct: TOUGH POISE	
1 2 3 4 controlled by others	5 6	7 8 9 10 self-reliant, independent	In: INDEPENDENCE	
1 2 3 4 unrestrained, sociopathic	5 6	7 8 9 10 restrained, responsible	Se: SUPEREGO STRENGTH	
1 2 3 4 immature, hedonistic	5 6	7 8 9 10 mature, subdued	So: SOCIALIZATION	
1 2 3 4 happy, positive outlook	5 6	7 8 9 10 melancholic, sad, withdrawn	D: DEPRESSION	
1 2 3 4 well integrated	5 6	7 8 9 10 disorganized thought, psychotic	P: PSYCHOTICISM	
1 2 3 4 well adjusted	5 6	7 8 9 10 unstable, neurotic	Ne: NEUROTICISM	

SECOND-ORDER WORKSHEET — FEMALE

Person's Sten Scores	Extraversion	Anxiety	Tough Poise	Independence	Superego	Socialization	Depression	Psychoticism	Neurotic
A	2								
B									
C		3						2	
E				3		1			3
F	3				2			2	
G			3		6	1			
H	3			2		1			
I			3						
L		2	3		2				2
M			3	3					3
N			3	2		3			3
O		3							3
Q_1			3	3		1			
Q_2	3			3		1			2
Q_3				2	6				2
Q_4		3					1		
D_1						3			2
D_2						3			
D_3			3			4			3
D_4				2					
D_5		2				3			
D_6		3						5 5	
D_7	3					2		2	
Pa								7	3
Pp						4			
Sc								4	
As									
Ps						2		4	
	4.4	2.2	10.5	1.1	1.1	8.8	1.1	3.3	8.3

SECOND-ORDER WORKSHEET — MALE

Person's Sten Scores	Extraversion	Anxiety	Tough Poise	Independence	Superego	Socialization	Depression	Psychoticism	Neurotic
A	2								
B									1
C		3							
E				3		1			4
F	3				2				
G			3		6	1			1
H	3			2		1			2
I			6						
L		2			2				
M			3	5					2
N						3			
O		3		2				1	4
Q_1			2	3		1			
Q_2	3			3		1			
Q_3					6				
Q_4		3		3			1		3
D_1							3		2
D_2							3		
D_3						4			
D_4									
D_5		2					3	4	
D_6		3							
D_7	3						2	3	
Pa								5	2
Pp						4			
Sc								5	
As									
Ps							2	3	
	4.4	2.2	9.9	3.9	1.1	8.8	1.1	0.6	5.0